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ADVANCED MATERIALS

France Boosts Advanced Materials Program

91AN0233 Toddington NEW MATERIALS INTERNATIONAL in English Jan 91 p 1

[Article: "Boost for PUMA Programme"]

[Text] The French Government's PUMA [Promotion of the Use of Advanced Materials] programme to encourage the use of advanced materials by small and medium-sized firms has been given a new boost.

This year some 200 million French francs [Fr] is being made available by the Ministry of Industry, a sum which is expected to help 10,000 companies.

During its test period over the last few months in four regions in France, the PUMA programme has provided Fr25 million for 110 projects. The financial assistance being offered comes in two forms. For the initial feasibility study, grants of up to Fr200,000 are available. However, PUMA support for the implementation phase of a project (up to Fr1.5 million) is expected to be reimbursed if the project turns out to be a success.

PUMA is targetting the use of new materials in its widest sense and includes composites and ceramics, plastics, glass, steel alloys, and so on. All industrial sectors are eligible.

Advanced Materials R&D Concentrated Around Grenoble Laboratories

Metallics, Ceramics

91WS0119A Paris INDUSTRIES ET TECHNIQUES in French 9 Nov 90 pp 60-63

[Article by Michel Le Toullec: "Materials: High-Value-Added R&D"]

[Text] Teamwork between researchers and industrialists in the realm of materials is not just a flight of fancy, nor are technology transfers and the valorization of research mere concepts, in the region of the Northern Alps. Advanced ceramics, metal-matrix composites [MMC], low-gravity metallurgy: These are all fields in which synergies are real.

True, the region is the home of world-class firms such as Pechiney, Vetrotex, and of the Atomic Energy Commission [AEC], the engines of various initiatives in these fields. But, principally, the region is notable because of its network of research centers, which complement, rather than compete with, each other, and which work very closely with the region's local enterprises.

Insofar as concerns actual transfers of materials-technology within the region, Madylam probably holds the record. This research laboratory of the National Polytechnic Institute at Grenoble [INPG], associated with the National Scientific Research Center [CNRS], has been in existence for the past 12 years. And its research work in the field of materials processing methods positions it advantageously from the standpoint of product development—a sort of obligatory cross-over.

"Principally," says Marcel Garnier, head of Madylam, "we receive two types of requests: First, there are those industrialists desiring to use this or that type of material, who consult us as to how to manufacture it. Then, there are those who seek to improve certain properties of their material by modifying their processing methods." Madylam has some 50 employees, half of whom are preparing their graduate theses.

The laboratory is credited with several extremely original technologies, such as a cold-crucible continuous casting process that is basic to the manufacturing of ultra-hard tungsten carbide spheres at Technogenia (Annecy), a carbide that is twice as hard as that produced by previous processes. But it is primarily in the domain of aeronautics that this process has taken on its true dimension. There it has opened the way to the recycling of titanium alloy chips by direct recasting. It is known as the 4C casting process, and has since been transferred to Cezus (a Pechiney subsidiary) at Ugine. As Marcel Garnier puts it: "We have blasted open a technological door against which everyone else, Americans and Japanese included, were bumping their heads. The economic stakes were sizable, involving as they did the recycling of chips resulting from the manufacture of aeronautical parts. These chips represent in some cases as much as 90 percent of the required 'starting' material from which the finished part finally evolves!" The process has also led to the introduction of a recycled-titanium alloy—GTI titanium—produced specifically for the automobile market.

Ceramics at Prices Ranging From 1,000 to 40,000 French Francs Per Kg

Among its other current cooperative ventures in the region, Madylam cites the development of a cold-crucible direct-induction furnace for the manufacture of high-value-added glasses by CFEI. As an alternative to the classic large refractory-lined furnaces—which are very slow to heat up and cool down—it could produce as much output as they, with a substantially smaller-sized installation.

Through its availability to the enterprises, Madylam today draws 90 percent of its financial resources—approximately 9 million francs [Fr], not including salaries of its permanent staff—from industrial contracts. But as a scientific research laboratory, it knows how far would be too far to carry technology transfers on its own. For this aspect, it relies on the Seri company as its interface with the industrialists. Based on the prototypes developed by the laboratory, the Seri company designs industrial-scale set-ups which it installs at production sites. The commercial aspect, on the other hand, is handled by DT21, an INPG subsidiary headed by one of the laboratory's former researchers.

Titanium metallurgy is also at the origin of the diversification of Extramet, a research contracting company created at Annemasse by two Batelle researchers. Long specialized in metallic powders and equipment for the treatment of industrial wastes, this firm is today in a strong position to compete with groups such as Bayer, Showa, and Atochem in very-high-technology ceramics. It has since created Cerex, a subsidiary devoted to these products, which opened a pilot production site in October.

The origin of this diversification goes back to 1982, when the French Government issued a call for bids on the production of titanium. "We were developing, as planned, a manufacturing process that would be less costly than previous processes," says Gerard Bienvenue CEO [chief executive officer] of Extramet and of Cerex. "This provided the company with a springboard. The process first proved highly advantageous for the production of titanium nitride and carbide, then for that of other metals such as zirconium, tantalum, and boron. To say nothing of the mixed composites, the carbonitrides." That is, some 20-odd products.

The ceramics are obtained directly in the form of powder, 0.1 to 1 micron in diameter, by germination in baths of molten salts at around 800 to 1,000 degrees C. A very interesting alternative to the carburizing (or nitriding) of metallic oxides at very high temperatures. These yield a product in bulk form that must be re-milled, often involveing the introduction of impurities during this stage. Gas-gas processes, on the other hand, yield a product that is so fine—around 1/100th of a micrometer—as to be difficult to manipulate.

The extent of the markets being targeted is as vast as the palette of potential products and their range of prices: From Fr1,000 to Fr30,000 or Fr40,000 per kilogram! "Initially, we expect two thirds, indeed three fourths, of our activity to be wear-resistance surface treatments." Plasma projection methods as well as incorporation in galvanic layers will be used to apply composite coatings. These will provide protection for tooling components, but also for automotive cylinder liners and turbine blades. The coatings test to a Vickers hardness number of 1500. Other applications of these powders include: grinding and polishing, fabrication of parts by sintering, and the design of composites, particularly since these powders can be used as "strengtheners" of a matrix's reinforcement fibers, for the realization of mechanical parts.

This process gained for Cerex a substantial grant (Fr8 million) from the Ministry of Industry, under the Major Innovative Projects program, and various fundings by the ANVAR [National Agency for Valorization of Research] and the AFME [French Energy Management Agency]. The firm was thus able to build a production site capable of producing some 10 metric tons during its first year of operation.

"Initially, the unit will be devoted to high-value-added products, with a view to achieving profitability as rapidly as possible," says Gerard Bienvenu. "Next it will concentrate on the less-exotic ceramics, such as silicon carbide and nitride."

In the case of silicon carbide, for example, Cerex participates in a EURAM [European Research on Advanced Materials] BRITE [Basic Research in Industrial Technologies for Europe] program (together, notably, with the German Lonza firm and the British Turner & Newal firm) devoted to thermostructural applications. Thus, Cerex expects to increase its output capacity from an initial 10 tons in 1991, to 40 tons within three years. "Beyond that, it will no longer be our business," says Gerard Bienvenu. "We will sell licenses to firms capable of producing on an industrial scale." Lonza would then be approached for the production of silicon carbide. Baikowski would be interested in other products.

Baikowski is already making some of its commercial contacts abroad, particularly in Japan, available to Cerex. To optimize the quality of its products, Cerex has been working together with the CEREM [Materials Study and Research Center] at Grenoble. The result has been a process that limits the problem of agglomeration of the powder during plasma projection.

Powder metallurgy is actually one of CEREM's specialties. The Center was created around the beginning of this year by the AEC, as an organization devcoted to basic, but also applied, research. It has a staff of 530 persons and a budget of Fr320 million. The Center's work complements rather closely that of Madylam, in that, besides the processing of materials, it also studies the characteristics and behavior of these materials in actual use. CEREM includes an industrial interface workshop (A2I) devoted to valorizing results. In particular, from the standpoint of powder metallurgy, the Center works on materials designed to operate under severe mechanical and thermal conditions, such as powder-reinforced alloys (dispersoids).

A Platinum Alloy That Withstands 1,200 Degrees C

"We have developed, for example, for Vetrotex, a new yttrium-oxide-powder-reinforced platinum alloy capable of containing melted glass at 1,200 degrees C," says Jean Spitz, head of CEREM. One of the roles of powder dispersed in a metal is to block the propagation of fissures. Such materials are of specific interest to the aeronautical and space markets (structures, motors, heat protection), but also to the realization of medical prostheses and mechanical parts.

CEREM also studies extensively the influence of microgravity on the processing of materials, and the particular properties resulting from it. "Microgravity has a very important influence on the growth of monocrystals, especially in the case of semiconductors such as the AsGa," says Jean Spitz. "The monocrystals obtained are of much higher quality and grow much faster than under

ordinary conditions. By thus limiting the number of flaws, faster charge carriers can be produced, and semiconductors made smaller."

These experiments require a very-low-gravity environment that can be achieved in various ways. The CENG [Grenoble Nuclear Research Center] has a 50-meter free-fall tube. The principle consists of releasing a drop of molten material at the upper end of this tube, the interior of which is at a maximized vacuum. Involved in this program one again finds Madylam, designer and builder of the device for "fabricating" the precisely calibrated drop. For low-gravity experiments of longer duration, the group can use the facilities of the CNES [National Center for Space Studies], including, in particular, a plane that flies parabolic trajectories. "For experiments in space strictly speaking, we will undoubtedly have to wait until 1992," says Jean Spitz. That will be under the MEPHISTO [Equipment for the Study of Phenomena Concerning Solidification on Earth and in Space] program. Under this program, initialed by NASA, the AEC will provide the instrumentation in exchange for six flights free of charge aboard the American Shuttle.

The group is also studying the processing of materials by rapid cooling methods, at rates in the order of 1 million degrees C per second [splat quenching] . The aim is to freeze the material in a structure that does not correspond to the habitual thermodynamic equilibrium of materials, and to obtain original properties with respect to those obtained by conventional cooling.

For example, splat quenching of aluminum-silicon composites, studied jointly with Pechiney and PSA [Peugeot Corporation], yields materials that are mechanically more resistant to heat. They are now being used as an alternative to castings and steels for the manufacture of automotive motors having a cylinder capacity of 3 liters. The process is also being used by Ugimag, a Pechiney Group subsidiary, for the manufacture of iron-neodymium-boron type magnets.

From the metallurgical standpoint, the region's flagship enterprise is, of course, Pechiney, whose research center at Voreppe employs more than 400 persons. The center is large enough to be self-sufficient, but from time to time it also uses the capabilities of laboratories in the region, such as Madylam and CEREM. Figuring prominently in the work of this group are two principal lines of research: MMC's and new alloys. Pechiney is, in fact, at the center of a GIS [scientific-interest group] concerned with MMC's. In the automotive sector, of course, its sights are set on applications under the hood. "Under a Eureka project, in which PSA, Renault, and Fiat are also involved, we have actually developed a cylinder-head insert made of an aluminum alloy reinforced with short aluminum fibers," says Salim Dermakar, leader of the powders and composites development group. The objective is to be able to insert the part during gravity die casting of the cylinder head—a process that enables optimizing the placement of the reinforcement in the zones that will have to withstand the highest operating temperatures."

Alu-Lithium Reduces Parts Weights by 15 Percent

Together with Aerospatiale, Pechiney has also developed a hollow-core material, made by the filament winding process, using continuous fibers of silicon carbide impregnated with aluminum alloy. The material could replace titanium, which is heavier, in parts having to withstand temperatures of 400 to 500 degrees C. "But it will probably be some 10 years before we see the first applications," says Salim Dermakar. The center is also counting on applications, particularly power-intensive ones, in the area of electronics.

As for alloys, aluminum-lithium composites continues to figure in the planning at Voreppe. Even if the plan of a production site, announced some time ago, is in a "holding situation," according to Jean-Louis Mazodier, head of the materials engineering sector. These alloys were developed as an alternative to the aluminum alloys being used in the aerospace industry. They reduce the weight of parts by 10 to 15 percent. But the damper on their utilization continues to be their price, which is three times that of Series 2000 alloys.

They are used, notably, in the landing gear spar of the ATR 42. Cime-Bocuze, a Pechiney wholly-owned subsidiary based near Geneva, is currently studying very-high-temperature alloys. The most recent of these, developed using powder metallurgy techniques, are molybdenum-rhenium and tungsten-rhenium alloys. They are capable of withstanding 1,300 degrees C and 1,600 degrees C, respectively, without structural changes, and are particularly suited for applications in aeronautics and space.

Carbides

91WS0119B Paris INDUSTRIES ET TECHNIQUES in French 9 Nov 90 p 82

[Article by Michel Le Toullec: "User-Friendly Tungsten Carbide"

[Text] The advantages of boosting wear resistance by means of a tungsten carbide coating need no further demonstration. This material's interesting properties are impaired, however, by oxidation during the metal spraying process. This oxidation, a chemical reaction, produces a poor bond, indeed no bond at all, between the coating and the base metal. Technogenia, which is based in Saint-Jorioz and specializes in surface hardening processes, proposes an astute solution: The use of tungsten carbide spheres that have previously been coated with nickel or cobalt.

"Solutions to this problem already exist on the market," acknowledges Pierre Brunet, the company's head of research and development. "In particular, sintered

spherical carbides or pseudo-coated crushed cast carbides. But this coating, generally obtained by mechanical means, yields a product that lacks homogeneity." The solution proposed six months ago by the company (Technofuse) concerns the hardening of smooth surfaces of relatively complex shapes to improve their resistance to abrasive wear: for example, the treatment of piston rods, wear-resistant linings, pump nonreturn valves, and other flap and check valves. The product is equally suited for use in conventional flame-spraying and metal-spraying, electric-arc spraying, laser-beam treatment (Metco), and even explosive-cladding (Plasmatechnik) techniques. It also permits rapid hardfacing. The nickel coating has a thickness of around five microns and a melting point of 890 degrees C.

Cold Crucible for Preparation of Carbide Spheres

Another advantage is that, during exposure, it softens and provides the spheres with a better "grip" on the substrate. By contrast, in the case of traditional powders, a large proportion of carbide spherules simply bounce off the substrate and are therefore lost.

These spherical carbide balls are prepared using the cold-crucible technique and are pulverized by liquid means. The technique has been developed over a period of several years by Technogenia and has enabled a doubling of the material's hardness and the attaining of 3000 to 4000 HV [Vickers hardness test number].

Ceramic Powders

91WS0119C Paris INDUSTRIES ET TECHNIQUES in French 9 Nov 90 p 92

[Article by Paul Molga: "Ceramic Powder Reinvented"; first paragraph is INDUSTRIES ET TECHNIQUES introduction]

[Text] Discovered by chance, this method of producing a very pure powder of good granularity was very quickly industrialized.

"The ceramics market is not the one we were long led to believe it would be. As recently as three years ago, in the belief that they were destined to replace metals in every sector, it was felt that the growth of the market would be exponential. The big groups, for the most part, therefore invested huge sums to master the technology only to find that their approach, logical and coherent though it was at its inception, has proven ill-suited to the demand." Although he takes a severe view of the market, Gerard Bienvenu, president of Extramet, a research contracting company in extractive metallurgy and materials science, is nevertheless confident as to its prospects: "Ceramics are a very-high-technology product that today concerns a multitude of small products and small markets." The latter are sectorial niches that are sustained by a highly exigent demand and adapt poorly to the imperfectness of current production techniques. A first method consists of fusing metallic oxides with carbon at an elevated temperature (2000 degrees C or more) to produce ceramic wafers that must be ground. The abrasive wear of the grinding machine introduces impurities that are impossible to eliminate. Another method is gaseous phase reaction, which yields powders that are too fine, often highly flammable (hence, danger of explosion), and that must be reconditioned.

Industrial Reactor To Produce 200 Kg of Powder Per Week in 1991

Extramet's chance encounter has changed this picture. The technology it has developed while seeking a new process for manufacturing titanium yields powders of good granular size (from 0.1 micron to 0.8 microns) directly and under comfortable working conditions (800 degrees C, normal pressure, homogeneous environment). "In 1980, while responding to a French Industry Ministry's request for bids aimed at countering the Soviet embargo on titanium," says Gerard Bienvenu, "our knowledge of calcium led us to develop a method based on synthesis in a molten bath." But the price of titanium, being prohibitive, compelled the enterprise to seek a cheaper substitute. Working with calcium carbide it produced, at the bottom of the crucible, titanium carbide, which it was able to market at several thousand francs a kilo. "A potential market of $15 billion by the year 3000," says Gerard Bienvenu.

Today, the process is protected by two worldwide patents. Its aim is strictly top of the line. "The demand in certain sectors for tooling of the highest reliability, such as drill bits and turbine blades, has straightaway provided us our initial objective. The other applications are hard to evaluate. In most cases, we offer powders for new markets where current products have proven ineffective." Nevertheless, the most pessimistic estimates of his business plan provide a glimpse of the enterprise's potentialities: 33 million francs(Fr) of revenue in 1993, with a net of Fr20 million, in sectors such as the aeronautics and space sector, the nuclear, and surface treatment.

It must be said that the process used by the company produces ceramics of unprecedented purity, hence of a hardness unequalled to date. The process consists of mixting two reagents in a molten salt bath: On the one hand, the calcium derivative—carbide or nitride—produced by the action of carbon or nitrogen in a calcium chloride bath; and on the other hand, a halogenide of the desired metal. The latter is generally in gaseous form (chloride of titanium, silicon, tantalum). The reaction produces the ceramic carbide or nitride powder as a precipitate.

The process had to be industrialized. Extramet lost no time in persuading the partners already holding its capital shares to invest the Fr10 million needed to create a subsidiary, Cerex, for the purpose of demonstrating the feasibility and reproducibility of results. An industrial reactor—designed with the aid of a grant of Fr8 million from the Ministry of Industry under the Major Innovative Projects program—is already operational and has just been inaugurated. It will produce 200 kg of powder

per week beginning next year. To justify this low tonnage, Gerard Bienvenu cites the newness of the sector: "We are counting on pilot markets, in which we will meet users with the same aim as ours: Mutual growth."

Irish Researchers Discover Magnetic Material

91AN0196 Rijswijk POLYTECHNISCH WEEKBLAD in Dutch 3 Jan 91 p 1

[Excerpts] Researchers from the Trinity College in Dublin have discovered a new magnetic material which offers promising prospects. The new material is a nitrided samarium and iron alloy which has major advantages over the presently available magnetic materials. [passage omitted]

So far, these magnets were made of alloys consisting of expensive and rare materials such as cobalt. The research, which started in 1985 within the framework of the European Community's BRITE/EURAM program [advanced materials], focuses on the phenomena occurring in the junction layers of alloys made up of rare earth metals, such as neodymium-iron-boron, which was discovered in the United States and in Japan in 1983.

However, the newly discovered material has several advantages over neodymium-iron-boron alloys: it is not subject to corrosion, it retains its magnetic properties at relatively high temperatures (475 °C) and it can be easily cast in any desired shape.

Siemens has already used the material to develop an isotropic magnet with an internal magnetic field intensity of 3 tesla, which is twice as much as the best neodymium magnets.

Research on nitride magnets, as these magnets are referred to, can eventually result in a major competitive edge for European industry.

AEROSPACE, CIVIL AVIATION

ESA Funds Space Transport Vehicle R&D

91WS0134B Paris LE MONDE in French 12 Jan 91 p 9

[Article entitled: "Europe Studies a Plan for a Space Supply Ship"]

[Text] The European Space Agency has just awarded a 1.4 million French franc [Fr] contract to three European manufacturers—Aerospatiale (France), British Aerospace (Great Britain), and Space Applications Services (Belgium)—for the study of an automated space transport ship to supply manned, orbiting structures.

The craft, christened LOVE and similar in design to the inhabited Soviet ships, the Progresses, is not due to fly before the next century. At that time it should service the future manned space structure EMSI planned by Europe. The new project should theoretically get underway after the Columbus program, scheduled to attach a manned European module to the American space station Freedom.

Europesat Program Launched

91AN0202 Paris ELECTRONIQUE HEBDO in French 10 Jan 91 p 16

[Article signed P.A.: "Europesat on the Launch Pad"]

[Text] The Europesat program, the second-generation direct-broadcast satellite project of the European Eutelsat organization, has been given the go-ahead. Nine countries, including France and Germany, have indeed ratified the memorandum of understanding which now authorizes Eutelsat to prepare a request for proposals for the contact to build the Europesat satellites. The request for proposals is to be issued within six months.

The European organization is planning three operational satellites by 1996-1997 as well as one spare in-orbit satellite. These four satellites will be located at the same orbital position of 19° West. This is not an accidental position: It was selected to ensure continued service—an indispensable condition for France—of the current direct-broadcast satellites TDF1/TDF2 and TVSat.

Moreover, the nine countries (Germany, Austria, France, Italy, the Netherlands, Portugal, Sweden, Switzerland, and Yugoslavia) requested at least 39 transponders for Europesat. Consequently, Eutelsat has to upgrade its project, which provided for 12 channels per satellite and 125-watt traveling-wave tube amplifiers. To this end, 5 million European currency units (i.e., about Fr35 million) have been allocated to perform these technical studies.

The first satellite could be launched in 1996 if the time schedule is maintained; the other launches would follow at the rate of about one launch every six months.

Possible Duplication of Standards by 1996

Coverage of Europe will be provided by steerable circular and elliptical spot beams which should furnish one EIRP (equivalent isotropically radiated power) of about 50-60 dBW throughout the area. As of 1996, it will thus be possible to duplicate networks in the HDTV standards and to keep telecasting in SECAM or PAL as well. However, due to the power of the satellite-borne transponders, TV viewers will have to obtain antennas 60-90 centimeters in diameter in order to have good reception of HDTV programs.

The Eutelsat organization has got down to another job, specifically at France's request, which has experienced a few setbacks in securing TDF1/TDF2. Eutelsat is indeed studying the possibility of launching an "intermediate" satellite by 1993 which would have the same basic specifications and would make up for the deficiencies of the TDF1/TDF2 tandem.

France: Advanced Climatic Wind Tunnel Operational

91AN0190 Paris RECHERCHE TECHNOLOGIE in French Oct-Nov 90 p 8

[Text] The Scientific and Technical Center for Construction (CSTB) has recently put into service a climatic wind tunnel that is a world first as regards its dimensions and its performance, with a capability of producing, on demand, wind, rain, Sahara sand storms, cyclones, and even nice weather. With its six fans, which represent a power of 3,200 kilowatt, the "Jules Verne" climatic wind tunnel can reproduce all the components of a given climate to evaluate a vehicle's tightness, resistance to erosion and to materials degradation, wind resistance stability, etc., while improving the efficiency of thermal systems (wind power engines, thermal collectors, etc.).

Minister of Research and Technology Hubert Curien and Minister of Public Works, Housing, Transportation, and the Sea Michel Delebarre, went to Nantes on 23 October, when the first stage was placed in service, to observe the equipment.

In its first stage, the wind tunnel features a dynamic circuit that allows two lines of experimentation to be pursued: the study of the effects of cyclone winds of up to 300 km/h; and the study of the effects of wind combined with various climatic parameters (rain, sand, smoke, sun, and aerosols).

During the second stage, a thermal circuit will be installed inside the dynamic circuit which will permit simulation of hot and cold atmospheric conditions, with or without snow or frost. This second stage, construction of which is to begin at the end of 1991, should be operational in 1993.

The Jules Verne wind tunnel meets the requirements of research and industry and numerous public and private contracts have already been entered into.

The project entails a total investment of 88 million French francs; it is cofunded by the French Government, regional and local authorities, and the CSTB.

[Box]

Performance of the Jules Verne Wind Tunnel (Stages 1 and 2)

Top wind speed: 310 km/h (30 m^2 section) Temperature range: from -25° C to 50° C (with a wind speed of 100 km/h) Humidity: from 20 to 100 percent Solar effect: solar spectrum with 1.4 kW/m^2 over a surface of 20 m^2 Snow storm: up to 30 cm/h with a wind speed of 100 km/h (70 m^2 section) Sand wind: 100 km/h (70 m^2 section) and 10 grams per square meter Wind and rain: up to 1 cm/minute over a surface of 100 m^2 (with a wind speed of 100 km/h)

German Institute Develops Atmospheric Remote Sensing Apparatus

91MI0157 Bonn TECHNOLOGIE-NACHRICHTEN MANAGEMENT-INFORMATIONEN in German 20 Dec 90 pp 10-11

[Text] A new measuring device called a MIPAS (Michelson Interferometer for Passive Atmospheric Sounding) has been developed and successfully tested at the Institute of Meteorology and Climate Research at the Karlsruhe Nuclear Research Center (KfK). This device can determine the concentrations of most major trace gases, such as ozone, methane, nitrogen oxides, or chlorofluorocarbons, either to an altitude of several dozen kilometers when earthbound or simultaneously and continually the world over when satellite-borne. The decision to use the system on the European Space Agency (ESA) polar platform in 1997-1998 and/or in the planned German environment satellite ATMOS in 1995 make it a pacesetter in remote sensing for ozone research.

Comprehensive global data bases on the state and composition of the atmosphere are necessary for an understanding of the causes of and interactive processes responsible for the additional greenhouse effect and ozone depletion, and for predictions of future developments. Remote sensing, which uses electromagnetic waves to carry information, is the best method for collecting global measurement data. Remote sensing from aircraft or satellites makes it possible to record widely-distributed parameters with a single instrument. The trace gases in the atmosphere constantly absorb and emit electromagnetic radiation in the infrared range. Each type of molecule has a characteristic radiation pattern, otherwise known as a spectrum, and the intensity of the radiation emitted or absorbed indicates the concentration of the gas molecules. If the intensity and wavelength of the radiation distribution emitted by the atmosphere are measured to give what is termed the emission spectrum, or if the sunlight filtered through the atmosphere is measured to give the absorption spectrum in the infrared wavelength range in question, in principle these spectra will contain the information about the concentrations of many trace gases in the sections of the atmosphere under consideration. The concentrations of the individual trace gases can then be deduced by complicated mathematical processes based on the known spectra of the pure gases. Initially, this method only supplies average values of the concentrations within the section scanned. If vertical stratifications or entire volumetric distributions are also to be measured, a process similar to sectional radiography must be used, whereby the atmospheric spectra are scanned at various angles to the horizon from aircraft or satellites; the volumetric distribution of the concentrations is determined from the scan, rather like the way X-ray tomography is used to produce three-dimensional images from inside the body. The newly developed MIPAS exploits the interference capacity of light waves. If two wave trains of equal amplitude and wavelength are brought into contact, periodic attenuation or amplification,

which is called interference, arises. This effect can be used to measure wavelengths by splitting the incident light on a semitransparent mirror in a device known as an interfe rometer.

The two beam sections are reunited via further mirrors. If the beam sections are rerouted by displacing the mirrors, a periodic light-dark phenomenon occurs at the exit from the device, which can be recorded as a variab' of the mirror position and used to determine the radıa-tion intensity as a function of wavelength. The different radiation emitted by the different trace gases can thus be identified from their intensity and wavelength, and their concentration can then be deduced.

In practice, this precision instrument must also survive the harshest conditions, such as transport to inaccessible areas, use in aircraft or stratospheric balloons, satellite launches, and space conditions. MIPAS therefore stands out for its particularly sturdy construction; in particular, a patented, high-precision, maximum reliability shift mechanism for the reflection mirror has been developed as a "double pendulum." MIPAS has already passed its acceptance tests in different versions in field use in Kiruna, northern Sweden, where it was used for research into the ozone hole, and in stratospheric balloons at altitudes up to 40 km. A version developed for use in aircraft is scheduled to participate in the major European ozone measurement campaign planned for 1991-1992. NASA expressed interest in MIPAS back in 1986, offering it a free flight on a Space Shuttle mission. In 1988 it was decided to install MIPAS on the ESA polar platform. Finally, MIPAS will also form part of the payload of ATMOS, an environment satellite that began life as a German initiative and is due to go into earth orbit in 1995.

Italy, USSR Sign Aerospace Agreements

91MI0147 Rome SPAZIO INFORMAZIONI in Italian 19 Dec 90 pp 2-3

[Text] The "small steps" policy on Italian-Soviet trade relations seems to have "contaminated" the first bilateral initiatives in the space sector to some extent. In fact, after the signing of the intergovernmental agreement on the exploration and peaceful use of extra-atmospheric space in October 1988, and the signing of the protocol on scientific cooperation by the Italian Space Agency (ASI), the Soviet Academy of Sciences, and Glavkosmos in November 1989, it appears that the time has come for the first moves at the industrial level. A good opportunity was offered at the recent conference on Italian-Soviet space cooperation held in Genoa by the Italy-USSR Association. In fact, a delegation of experts from Interkosmos, the Soviet State Committee for Science and Technology (GKNT), and Glavkosmos arrived in Italy for the occasion. After attending the conference, the Soviet delegation split up into various groups to visit the major national space companies (Aeritalia, Selenia Sapzio, Fiat Spazio, Laben, Fiar, Telespazio, Officine Galileo, Ansaldo, and Elsag). These visits, which permitted specialized industries to demonstrate their technological and manufacturing capabilities, also lead to some concrete results.

The Rome delegation of Soviet experts was led by the department director of the Ministry of General Machinery Building (MOM), Vice Minister Boris Dmitrevic Ostroumov, who signed two memorandums with respresentatives from Selenia Spazio (IRI [Institute for the Reconstruction of Industry]-Finmecannica group) and Fiat Spazio. The agreement with Selenia Spazio was signed by the company's managing director, Andrea Pucci. It involves, first of all, an exchange of information with MOM on the use of Soviet carriers for the SARIT (Italian Television Broadcasting Satellite) satellite launch in 1993, and for other satellite launches. The one-year, renewable "memorandum," also provides for a visit to the USSR by a technical delegation from Selenia Spazio in the near future (probably in January 1991) to further examine the opportunities for cooperation in this sector with MOM.

Vice Minister Ostroumov also signed an agreement with Fiat Spazio in Rome. The document, signed by Antonio Fabrizi, the Fiat group company's managing director, provides for an exchange of preliminary technical data between Fiat Spazio and the Soviet Lavockin Association on Italy's possible participation in the Mars exploration mission. MOM also appears to be interested in Fiat Spazio's "In-Orbit Refueling System" project and in proposing the joint development and manufacture of a small telecommunications satellite and its earth station. The agreement also specifies that MOM will evaluate the possibility of supplying Fiat Spazio with remote sensors for small satellites. Finally, Italian-Soviet cooperation for carriers similar to those currently being manufactured in the USSR is being hypothesized, together with studies on the development of the new San Marco Scout carrier. A technical delegation from Fiat Spazio will leave for the Soviet Union next February to further examine this proposal.

Italy, Germany Develop Ionic Propulsion System

91MI0167 Rome AIR PRESS in Italian 2 Jan 91 p 51

[Text] The RITA (Radiofrequency Ionization Thruster Assembly) ionic thruster developed jointly by FIAR and MBB [Messerschmitt-Boelkow-Blohm] has been fully integrated and tested at Giessen, Germany.

The outstanding feature of the ionic thruster is its specific thrust or, more simply, the thrust produced in relation to the propellant used. The newly-developed propulsion unit is capable of generating a specific thrust that is at least 10 times greater than that generated by the more traditional chemical units. This engine will be used on interplanetary exploratory missions, where a limited propulsive thrust is applied for long intervals to carry out orbital changes: by using less propellant, ionic propulsion enables the satellite to carry a heavier scientific payload. The principal applications of the FIAR-MBB

thruster will be in the area of telecommunications satellites. In fact, the orbiting life of a telecommunications satellite depends on the amount of propellant needed to perfom the numerous operations required to correct the satellite's orbit and position. As a result of the reduction in propellant consumption created by ionic thrust, the operational life of telecommunications satellites will increase from the current seven to ten years to at least 13 to 15 years. On 1 January 1991, FIAR entered into the Finmeccanica and Breda Finanziaria holding companies.

Italian Telecom Satelite Launch Preparations Described

91MI0146 Rome AIR PRESS in Italian 12 Dec 90 pp 3011-3013

[Text] Italsat, the ASI's (Italian Space Agency) national telecommunications satellite, will be launched the night of 15 January 1991 by an Ariane 4 carrier (flight 41, launcher 44L) from the Kourou space center in French Guyana together with the European telecommunications satellite Eutelsat IIB. Italsat was designed and developed by Selenia Spazio, an Alenia company of the IRI [Institute for the Reconstruction of Industry]-Finmeccanica group.

After having successfully completed its testing campaign (February-October 1990) at the Intespace center of Toulouse, Italsat was transferred to Kourou on 6 November 1990 where the launch preparations campaign began. Selenia Spazio will be directly responsible for this phase, which will involve about 50 of its technicians, under the supervision of the ASI. The phase will include operating tests and the final integration of the satellite, filling the tanks on board, placing the satellite on the Ariane 4 carrier, and final launch operations.

The final checks on the satellite and all the subsystems on board, and the integration of the solar panels and antennas began on 6 November and will be completed on 10 December. The extremely delicate three-day operation of loading the satellite's fuel tanks with the 915 kg of propellant required to put the satellite into orbit and maintain it there for more than five years will begin immediately after. Once these operations are completed, the satelite will be ready for final operations with the second satellite (Eutelsat IIB) and the Ariane 4 carrier. These activities will begin when the Kourou center reopens after the Christmas break at nine days to takeoff and will involve: placing Italsat in the upper part of Spelda, the structure located at the top of the third stage of the carrier which permits double takeoffs; attaching the thermal shields (-eight days); placing the second satellite in the lower part of Spelda (-seven days); moving the two satellites to the takeoff area (-six days); placing the Spelda structure containing the two satellites in the carrier. At this point the satellite will be connected by an umbilical cord for fueling, and via radio to monitor the state of the equipment by telemetry (-five days).

The final activities on the two satellites and carrier will include the following operations: the final preparation of the carrier; charging Italsat's batteries (-four days); a general test of the final countdown (-three days); final operations on the carrier and continued charging of Italsat's batteries (-two days); filling the first and second stages of the carrier and the continued charging of Italsat's batteries (-one day).

The final operations will begin on the day of the launch (at -12 hours to takeoff) and include: final checks on the two satellites and the carrier, filling the third stage of the carrier (at -3 hours 35 minutes), placing the two satellites in a launch configuration (-one hour eight minutes). The final automatic sequence of operations will begin at -6 minutes and includes checking all the systems to switch the satellites over to internal power; transferring the carrier's instruments to internal power (-one minute); opening the inertial exchange [centrale inerziale] (at -9 seconds), and the cryogenic arm aperture command (at -4 seconds); and the ignition of the carrier's first stage (at -2 seconds to takeoff).

In parallel with the activities in Kourou, operations are being finalized to manage the very first phase of the satellite's orbit and its positioning in space (13 degrees E): orbital maneuvers, spreading the solar panels, engine ignition. These operations will be carried out by ESOC (the European Space Agency's control center in Darmstadt, Germany) with the participation of Selenia Spazio's project group and under ASI's supervision. Selenia Spazio has specified the requirements for all the scheduled phases of the satellite's orbital mission.

Italsat is the first all-Italian telecommunications satellite. Of extremely advanced design, it operates at high frequencies (20/30 GHz) using digital technology. On Earth, control and connecting stations will handle part of the national telephone traffic. Thanks to Italsat it will be possible to increase the flexibility and operations of the national networks with which it will be integrated. Its on-board switching functions, which makes it an authentic telephone center in space, will permit telephone lines to be assigned according to need. It will use 20-30 GHz digital telephony with multibeam national coverage and a 1,200 telephone circuit capacity to create a more flexible national telephone network, and will provide nationwide consumer services (experimental videoconferences, newspaper transmission, high speed connections between calculators, emergency connections) at 20/30 GHz. In addition, propagation experiments are anticipated at 40/50 GHz for future European-wide telecommunications systems.

Selenia Spazio was the prime contractor for the Italsat program. It was responsible for designing, developing, constructing, and testing the satellite and the three telecommunications missions, the connecting and controlling stations on Earth, and the Earth-to-space telecommunications system. The value of the basic contract between ASI and Selenia Spazio amounted to 410 billion lire for the construction of the satellite and 136 billion

lire for the construction of the Earth stations. The total value of the space-Earth contracts amounted to 546 billion lire. Selenia Spazio's share for the satellite was 251.5 billion lire, amounting to 58 percent of the total value and its share for the Earth stations was 102 billion lire amounting to 75 percent of the total. The overall value of Selenia Spazio's participation therefore amounted to 353.5 billion lire.

Selenia Spazio has already started on the second Italsat F2 satellite which will be completed and delivered in August 1993. Once Italsat F2 is in orbit the experimental digital telephone system will become operational after being integrated into the SIP [Italian Telephone Company] telephone network.

In the future, Selenia Spazio will be able to exploit the experience acquired in this program in other national and European telecommunications programs. In particular, the Italsat satellite's platform will be used at national level for SARIT, the direct television broadcasting satellite, and for SICRAL the telecommunications satellite used for civil defense. The platform will be used at the European level for the ARTEMIS [Research Workshop for Systems Mathematics and Data Processing Systems] telecommunications satellite and for the DRS (Data Relay Satellites) satellites. Selenia Spazio is the prime contractor for these programs.

AUTOMOTIVE INDUSTRY

Norwegian Company Founds Aluminum-Producing Subsidiary

91MI0169 Duesseldorf HANDELSBLATT in German 18-19 Jan 91 p 13

[Text] Oslo-based Hydro Aluminium A.S., which belongs to the Norsk Hydro concern in Oslo and, with its 17 billion German mark [DM] sales income and more than 33,000 employees worldwide, is Europe's largest aluminum manufacturer, is stepping up its efforts "to replace steel to a large extent with aluminum" in the automobile industry.

Although aluminum is three times as expensive as steel as a raw material, the price difference could be offset to a great extent by construction and other advantages, such as lower weight and gasoline consumption, ease of processing, and simple, cheap recycling, said Hans-Georg Mangold (48), a director of Hydro Aluminium Extrusion S.A., its Lausanne subsidiary.

A new subsidiary, Hydro Aluminium Automotive GmbH, has been founded for this purpose in Munich. In view of the strong position of the German automobile industry, especially as regards technology, Hydro Aluminium intends to concentrate its worldwide automobile work in Munich. With 30 employees to start with, the Munich center will direct research and development, and also marketing, financial aspects, and controlling. The number of employees will increase considerably over the next few years.

Hydro Aluminium has spent some DM80 million to date on research and development projects, factory takeovers, and increasing production for the automobile sector. Sixty-five million German marks of these will now be handled from Munich. In the meantime, 26,000 tonnes, i.e., 10 percent of Hydro Aluminium Extrusion's pressed parts production, are already being delivered to the automobile industry. This is equivalent to annual sales of DM300 to 350 million.

Mangold estimates annual growth rates at 10 to 15 percent. But when the Eureka [European Research Coordination Agency] Space-Frame bodywork project, developed jointly with Renault, goes into production, a much faster expansion rate will be achieved, as it will be implemented in a mass produced car, which would take on a pilot role in this sector.

Munich will have control over four aluminum plants in the United States, two of which were only acquired last year, a Norwegian automobile wheel rim factory, an aluminum extrusion plant in Toender, on the German-Danish border, and a factory in Nenzing, in the Vorarlberg [Austria]. The new automotive subsidiary's capital stock amounts to DM2 million. Its parent company, Hydro Aluminium A.S., of Oslo, achieves sales equivalent to DM4.5 billion with a share capital of 270 billion Norwegian kroner and 11,000 employees.

In the automotive sector, Hydro Aluminium already leads the market for the aluminum pipes used in vehicle heat exchangers and air conditioning. Then there are the aluminum wheels that the company supplies, for example, to BMW, Saab, and Volvo.

Aluminum consumption is currently 64 kg per car in Europe and 75 kg in the United States. Optimistic estimates assume that its use will double or even treble to 272 kg of aluminum, at least in the United States, by the end of the century. In the future, aluminum will not only be used to cast engines en bloc, cylinder heads, pistons, and wheels, but will also be adopted for bodywork, to produce chassis.

Although the production of crude aluminum is energy-intensive, this energy is well invested, as the material is an energy store and is also a readily recyclable metal, says Ivar Hafsedt, chairman of Hydro Aluminum Extrusion S.A. In addition to recyclability, weight reduction is another very important factor in automobile design, as it makes for a reduction in gasoline consumption. It is well known that the target for gasoline consumption is a reduction from the current 8.7 liters to 5.6 liters per 100 km by the year 2000. The aluminum Space concept sets out to reduce bodywork weight by 40 percent.

Provided the right alloy is used for the structure concerned, aluminum can provide an even more marked crumple zone effect than conventional sheet steel bodies,

so there can be no objections from the safety point of view. Mangold cites shorter development times for new models and cheaper model changeovers as further advantages of aluminum as an automobile material.

Use of Nylon by UK's ICI Described

91AN0234 Toddington NEW MATERIALS INTERNATIONAL in English Jan 91 p 3

[Article: "ICI Nylon Used in Car Radiator Systems"]

[Text] Maranyl nylon from ICI is being used to produce car radiator end-tanks in place of the usual copper, brass, or aluminium. Blackstone, a leading supplier of cooling systems to the automotive industry, is using the nylon end-tanks on systems supplied to car manufacturers including Fiat, BMW, and Volvo.

The company first produced a cooling system with a nylon end-tank for Volvo in 1983. It was made from Maranyl A 175S, a 30-percent glass-fibre-reinforced, hydrolysis-resistant nylon 66.

Blackstone found it was able to mould-in the inlet and outlet connections to the core rather than having to fabricate them separately and join the parts together, as was normal with the metal versions. Beside this ease of manufacture, the use of the nylon also brought a weight saving in the finished system.

Maranyl A 175S is resistant to chemicals such as oil, grease, and glycol found in engine environments, and copes with temperatures of +130°C to -40°C, the quick change in the temperature experienced on startup, and pressures of up to 2.5 bars.

The end-tanks are injection-moulded in Sweden by Plastal.

BIOTECHNOLOGY

France: Genetic Engineering Robot Developed

91AN0144 Paris SCIENCES & AVENIR in French Dec 90 pp 6, 7

[Article: "Robot Identifies Myopathic Gene"]

[Text] After the Telethon comes the Genethon. This is a project that does not take place before the eyes of TV cameras, but on the second floor of the building of the French Assocation Against Myopathic Diseases (AFM). And it does not last one evening, but will continue for many years. "The objective is to accelerate by a factor of 10 or more our knowledge of hereditary diseases," declares Daniel Cohen, director of the Study Center for Human Polymorphism (CEPH). "If formerly seven years were needed to locate and identify the gene of an hereditary disease, such as mucoviscidosis or myopathy, it can now be done in seven months."

Genethon is based on the results of a French-British EUREKA project called Labimap (Laboratory For Automated and Programmable Molecular Biology), which involved two industrial concerns (Bertin in France and Amersham International in Britain) and two science centers (the CEPH in Paris and the Imperial Cancer Research Fund (ICRF) in London). A series of robots were designed capable of carrying out often time-and labor-consuming biomolecular engineering operations, ranging from DNA extraction from blood samples to DNA analysis. Twenty "Mark 2" robot prototypes have been installed at the AFM. They will do the work of 150 people. The task is enormous: More than 3,000 genetic diseases are known, but so far the genes responsible for fewer than 30 diseases have been identified.

These diseases affect one child in a 100, and they are the cause of 30 percent of all cases of infant mortality. They also account for almost 50 percent of adult pathologies, because the hereditary traits causing cancer, diabetes, high blood pressure, and such psychiatric diseases as schizophrenia and manic-depressive psychoses have to be included.

Only just launched, the Genethon project is already a success: In less than two months, CEPH researchers have identified the gene responsible for waist myopathy, which affects the muscles of thighs and hips and generally causes the death of affected people at the age of around 50.

BMFT Allots DM1.5 Billion for Biotechnology Research

91WS0115A Duesseldorf VDI NACHRICHTEN in German 23 Nov 90 p 24

[Article by Christa Friedl: "Molecules Against Depressions and Swine Fever"]

[Text] The Federal Ministry for Research and Technology [BMFT] is opening its cash boxes to biotechnology. By 1994, 1.5 billion German marks [DM]—financed jointly with the German Research Association and the Max-Planck-Society—are to open up promising new fields for German biotechnology research.

Biotechnology is not gene technology. When representatives of the BMFT talk about biotechnology they rarely mean work with genetically altered organisms. "Primarily, biotechnology is extracting, altering and disposing of materials with biological methods and processes," according to Ekkehard Warmuth, department head at the BMFT. Primarily also cheese and wine production, biological purification of waste waters in sewage treatment plants or cleaning up contaminated soils.

Bacteria play the principal role in modern biotechnology research, In medicine, environmental protection and even in energy production, they are to help solve problems. But research with living organisms is expensive and time-consuming. The BMFT thus started an initial research support program in 1986. Cost: DM1 billion,

distributed over five years. (In comparison: The world-wide spending of FRG industry for biotechnology amounts to approximately the same amount; about one-fourth of the funds is used in the [old] FRG.)

The finances get a another shot in the arm with a new Biotechnology 2000 program. The funding was increased by 50 percent to DM1.5 billion for the years 1990 to 1994. The BMFT (including major research establishments) contributes DM450 million, the German Research Association in Bonn DM350 million and the Max-Planck-Society, Munich DM430 million.

Program With 12 Points of Emphasis

The program includes 12 points of emphasis, from method development, through protein design and plant breeding, to methods that replace animal testing and biological safety research. "Where the focal points ultimately are will be determined by practical application," said Warmuth when presenting the program last week in Bonn.

A "classic" field of biotechnology research is vaccine development, since all the questions in this area have by no means been answered. One example: swine fever. No sufficiently effective vaccine exists today for this financially quite devastating virus disease, and even today no certain way to diagnose it has been developed.

"By means of molecular modelling we are now trying to develop a vaccine, to which the virus can no longer develop any resistance," according to biologist Barbara Rath of the Juelich research establishment. The Juelich working group did not begin its search just recently. Successful immunization of mice was achieved between 1988 and 1990. The new vaccine is to be identified and receive its final polish by computer (with financial help from a German pharmaceutical manufacturer) by 1993.

A field of biotechnology new to Germany is brain research. "Gene technology makes it possible to understand and modify the processes in the brain," says Dr Wolfgang Finger of Tuebingen University. In the long term, central nervous system illnesses, brain diseases such as schizophrenia and depressions, or brain lesions after accidents, could then be selectively treated. For example, one is looking for biochemical materials in the body which could build up new cells in the central nervous system.

At the same time largely unresearched is the function of the so-called glia cells in the brain. "Until now it was believed that the glia cells are only some sort of nerve glue," according to Finger, coordinator of the BMFT's neurobiology program. Today, scientists assume that this" glue" also plays a role in information processing.

The search for a vaccine against swine fever on the one hand and for a brain repair factor on the other have this in common: They are part of a market-economic trend. As recently as last year the effects of the disease sweeping through Belgium cost DM14 million. And it is beyond doubt that there is a major market for brain therapeutics. According to Finger, about 1 percent of the world's population suffers from schizophrenia and 4 percent from depression. Research Minister Heinz Riesenhuber put his finger on it: "There is no sense in working against the market."

Fate of Eastern Research Continues To Be Uncertain

Whether biotechnology research in the former GDR, which enjoyed quite an acceptable reputation worldwide, will survive in the future is an open question. "The fate of individual institutions depends on their scientific qualifications and their potential assignment to western institutions," according to Professor Joachim Klein, head of the Society for Biotechnology Research in Braunschweig. The Fraunhofer Society in Munich was the first to put out a feeler. Intensive negotiations are presently under way concerning a takeover of the Central Institute for Microbiology and Experimental Therapy in Jena (Zimet).

Safety Check for Artificial Microbes

Experiments with the release of genetically altered living things have been undertaken more than 200 times so far. Since their spreading in the environment can be relatively well controlled, the interest has primarily been focused on plants. But even transgenetic bacteria and viruses are no longer multiplying exclusively behind hermetically sealed laboratory walls. The Battelle Institute has now examined the potential danger for humans and environment in a study. Scientists from the highly regarded Frankfurt scientific institution developed a series of test procedures, with which genetically altered microorganisms can be studied as to their risk potential.

Among other things, tests are being conducted to determine whether genetically manipulated microorganisms are able to survive at all in free nature and are able to compete with their naturally occurring relatives. In additional test series the question of whether the information inserted into the genetic material can be transferred to other living things will be pursued.

In this project, water from the Main river serves the microbiologists and geneticists as an artificial environment. The multiplication rate in these media provides an indication of the survival capability in competition with the natural microflora. It is possible to determine by means of a very similar method whether and to what extent genetic material can be transferred to other organisms.

At present the Battelle team is working with a strain of bacteria (pseudomonades) which is already capable of reducing pollutants such as aromatic hydrocarbons. This capability is to be optimized in the future by using methods of gene technology.

According to the study, transmission of genetic traits between microorganisms is possible in principle, but

depends greatly on the individual bacterial strain. A universal statement on this fundamental problem therefore cannot be made.

Germany: BMFT Launches Biotechnology Plant Design Project

91MI0196 Bonn TECHNOLOGIE-NACHRICHTEN MANAGEMENT-INFORMATIONEN in German 18 Jan 91 p 3

[Text] The law on genetic engineering and the five major regulations on the subject, which came into force in early November 1990, form the legal framework for the use of genetic engineering in Germany. Registration and approval procedures for genetic engineering plants will give rise to certain difficulties here and there in the running-in period, as there is still a lack of relevant experience. Research institutes and companies do not always have adequate knowledge as to the safety and approval criteria that must be taken into account and how best to proceed. The same is true of the authorities responsible for enforcing the law, which have to cover a wide variety of highly different plants.

To improve this situation, the Federal Ministry of Research and Technology (BMFT) is providing subsidies of approximately 3.6 million German marks [DM] for a DECHEMA [German Chemical Apparatus Engineering Society] joint project involving various subcontractors. During the first phase of this four-year project, basic data and criteria for the construction and operation of genetic engineering plants will be drawn up. Material on safety-relevant procedures and design criteria and a report on the capabilities and limitations of metering and detection methods will be of fundamental importance. Material will also be collected for use as criteria for risk assessment and minimization in genetic engineering work. Special account will be taken of the need to maintain safety when operating genetic engineering plants. Since there are to date no comprehensive specifications for an integrated safety assessment covering organisms, biological processes, plant components, and plants for genetic engineering installation planning purposes, an overall concept will be developed to take account of all relevant technical and biological aspects. The topics addressed will include biological safety, apparatus and plant engineering, environment protection/waste disposal, metrology/detection methods, and system engineering.

The project will lay the foundations for proper interpretation and implementation of the legal regulations, for approval and application procedures, and for the development of standards and norms. A second phase of the project will address gaps in knowledge that emerge during compilation of the basic data.

Additional information is obtainable from Dr. Rolf Marris, DECHEMA, Theodor-Heuss-Allee 25, 6000 Frankfurt 97, Tel. 069/75640.

COMPUTERS

EC Market Council Agrees on Software Protection

91AN0153 Brussels EUROPE in English 15 Dec 90 p 12

[Article: "Internal Market: Contents of the 'Joint Position' of the Council on the Legal Protection of Computer Programmes"]

[Text] Brussels—The Internal Market Council on 13 December has finalised its "joint position" on the modified draft directive relating to the legal protection of computer programmes. The main idea of the directive is that software should be protected by copyright in the same way as literary works, but that it must be able to undergo reverse engineering (inverted analysis from the final product to the component elements) in order to make new software interoperable, that is, able to communicate between themselves. There was unanimity on the joint position but the Irish delegation made a unilateral declaration recognising that payment for reverse engineering is possible. Below are the main provisions of the directive:

1. Member States protect computer programmes through copyright in the same way as literary works in accordance with the Bern Convention on literary and artistic works. The protection of a programme (the definition of which includes the preparatory design material) is ensured during the author's lifetime and for 50 years after his decease (or after decease of the last surviving author). The Member States where legislation stipulates a longer protection period (FRG) will be able to maintain this until copyright legislation is harmonised at Community level.

2. Protection applies to any form of expression of a programme. Ideas and principles which are at the basis of any element of a programme, including those which are the base of its interfaces, are not protected by the directive.

3. The copyright holder has exclusive right to make and to authorise:

- The permanent or temporary reproduction of a programme;
- The translation, adaptation, arrangement and any other transformation of a computer programme;
- All forms of distribution including public hiring of the original or of copies of a computer programme.

4. Certain acts which, in general, are subject to the authorisation of the holder, do not require such authorisation when they are necessary to enable the legitimate purchaser to use the computer programme in a way that is in conformity with its destination, including for the correction of errors.

5. Authorisation from the copyright holder is not required for the analysis of a programme which is indispensable in order "to obtain the information necessary for interoperability of a computer programme created in an independent manner with other programmes." Reverse engineering of a programme is therefore legal when it allows dialogue and work to be effected with new concurrent programmes. Certain conditions must therefore be fulfilled for a programme to be analysed legally:

- Acts necessary for reverse engineering must be carried out by the patent holder or any other person entitled to use a copy of a programme;
- Information necessary for interoperability has not yet been easily and rapidly accessible to the licensee;
- Reverse engineering is limited to the parts of the original programme necessary for this interoperability.

6. Information obtained with a view to reverse engineering of a programme cannot be:

- Used for ends other than achievement of interoperability;
- Communicated to third persons, except if this proves necessary for interoperability;
- Used for the perfecting, production, or marketing of a computer programme the expression of which is basically similar or for any other act which could jeopardise the copyright.

7. On the other hand, the Member States should take appropriate measures—such as seizure—against persons who:

- Put a copy of a programme into circulation in the knowledge that it is illegal;
- Hold a copy of a programme to commercial ends in the sole aim of facilitating the non-authorised elimination or neutralisation of any technical device likely to be set in place to protect a programme.

The provisions of the directive should be enforced by Member States before 1 January 1993. They will also be applicable to computer programmes created before this date. The Council's "joint position" has now been transmitted to the European Parliament.

European R&D Consortium Goals, Projects Outlined

91MI0181 Sankt Augustin GMD SPIEGEL in German, Dec 90 pp 34-39

[Article by Professor Gerhard Seegmueller, GMD board chairman: "ERCIM: A European Research Institute Consortium and the Vision of European Cooperation"]

[Excerpts] ERCIM, the European Research Consortium for Informatics and Mathematics, provides a concrete example of European cooperation. [passage omitted]

The idea behind the European Research Consortium for Informatics and Mathematics denotes cooperation at the European level in our field: computer science and the relevant areas of mathematics. [passage omitted]

The three founder members of ERCIM are the [Dutch] Science and Informatics Center (CWI), the [French] National Institute of Informatics and Automation Research (INRIA), and the [German] Mathematics and Data Processing Association (GMD). They have joined forces and reaffirmed their intention to achieve and contribute more than they would have been able to as individual organizations.

The three founder members of ERCIM met in April 1989, when they signed an agreement on scientific cooperation at the GMD in Birlinghoven. Scientists and administrators had already met on several occasions and had a lively exchange of ideas. However, the idea of Europe and the prospects opened by the Single European Act, together with the determination to play a leading role in the development of computer science, placed the existing, very loose form of cooperation on a higher plane and gave it a decisive boost.

ERCIM's members are major national research institutes specializing in computer science and mathematics. They account for a considerable share of public research at the national level, including know-how transfer at the highest level. They cooperate with other scientific circles and industry, have carried out various joint programs with their partners, and are considered, both in their own countries and abroad, as national centers of excellence.

The Rutherford Appleton laboratory in the UK has recently accepted the invitation to become the fourth member of this venture. Indeed it is ERCIM policy that membership be open to other organizations in other European countries. ERCIM has an overall research capacity of 1,700 scientists and a budget of 144 million European currency units [ECU]. Inevitably, resources must be fought for every year, and the existence of this capacity must be justified every time. However, cooperation is under way, and this is to the advantage of both scientific and industrial partners and the European taxpayer.

ERCIM's Objectives

The ERCIM members have set themselves to promote research into computer science and the relevant areas of mathematics on a European scale. They will also contribute significantly to the development of future European research programs and to the identification of research areas requiring special attention in Europe. They will, moreover, contribute to drawing up research programs that avoid duplication of work so as to cover more fields or study specific fields in greater depth. Their pooling of resources and knowledge will improve Europe's position on the global research and technology market.

ERCIM joint initiatives significantly improve the European computer science research situation. We shall first focus on measures that produce short-term results to avoid investing high sums at the beginning:

- Joint workshops on a regular basis;
- Publication of a scholarship program;
- Cooperation on high-level training;
- Publication of a joint journal appearing at regular intervals;
- Coordination of project research.

ERCIM Workshops

Twice a year, ERCIM organizes scientific workshops at one of its member organizations. The first of these events was a bilateral CWI-INRIA symposium in 1988. So far, five workshops have taken place following topics such as:

- Scientific high-performance computing;
- Man-machine communications;
- Object-oriented graphics and interfaces;
- Concurrency;
- Data protection and data integrity;
- Software for parallel systems;
- Production of multimedia documents.

The latest workshop was held in Amsterdam in November 1990 on the following topics:

- Image analysis;
- Computer algebra;
- High-speed networks.

In general, about 80 scientists employed by ERCIM members attend these workshops, which have proved to be an ideal forum where our researchers can exchange ideas and present status reports on their work before the results are actually published. Obviously, they have also contributed to the corporate identity of ERCIM, an achievement that we had not at all expected at such an early stage in our cooperation.

These workshops were initially intended purely as ERCIM meetings for internal discussions and presentations, but we very soon decided to open them, to a certain extent, to external research workers.

This approach shows once again that ERCIM is not merely inward-looking but sees itself as a open forum for international scientific exchange in accordance with a long-standing traditional worthy of support. [passage omitted]

ERCIM's Members

CWI (Centrum voor Wiskunde en Informatica) is the research institute of the Stichting Mathematics Center in the Netherlands. Since its foundation in 1946, CWI's policy has been to foster the systematic development of mathematics and computer science. Its three basic priorities are:

- Advanced research (primarily basic research);
- Knowledge transfer and specialized training in the academic research sector of industry and government departments;
- Development of CWI into a national and international meeting place for research workers

CWI has six departments (three specializing in mathematics and three in computer science) mainly covering:

- Analysis, algebra, geometry;
- Operations research, statistics, probability and system theory;
- Numerical mathematics;
- Algorithms and architectures;
- Software engineering;
- Interactive systems.

CWI has a budget of ECU7.2 million and a staff of 220, 150 of whom are scientists.

INRIA (National Institute for Research on Information Science and Automation) is the major computer science and automation research institute in France.

Its work includes:

- Pure and applied computer science and control theory research;
- Experimental system and prototype design;
- Evaluation and transfer of results to industry;
- Knowledge transfer in general;
- Funding international scientific exchange.

Its research focuses on software problems and automation engineering. INRIA has a staff of about 1,000, including 650 scientists. Its budget totals ECU45 million, 20 percent of which comes from contracts and licenses.

GMD (Mathematics and Data Processing Association) is the major German computer science research institute.

Its scientific work falls under the following broad topics:

1. Parallelism, which comprises the following subtopics:

- Massively parallel systems;
- Innovative programming and computing systems;
- High-performance computing centers and scientific high-performance computing.

2. Innovative design environments, which comprises the following subtopics:

- Software factory;
- VLSI [very large-scale integration] design.

3. User-friendly communication systems:

- Telecooperation;
- Open broadband communication system.

4. Integrated application systems:

- Assistance computer [Assistenz-Computer]
- Active book [Aktives Buch].

GMD has around 1,400 employees, 900 of whom are scientists. It has a budget of ECU72 million, 30 percent of which it earns from projects and contracts.

RAL (Rutherford Appleton Laboratory) is the largest institute under the control of the Science and Engineering Research Council in Great Britain.

RAL comprises three departments engaged in computer science. Its work falls into the following broad topics:

- System engineering;
- Computational modelling;
- Distributed systems;
- Software development;
- Communication systems;
- Electron beam lithography;
- VLSI design.

RAL has a staff of 1,400 including 700 scientists and engineers. The areas listed above involve 285 employees. Its total budget amounts to ECU98 million, with the computer science share accounting for ECU19.7 million. [passage omitted]

ERCIM's Strategies on Joint Projects

We carry out research work under various projects. ERCIM members have been working together for many years on major EC programs such as ESPRIT [European Strategic Program for Research and Development in Information Technologies], RACE [Research and Development in Advanced Communication Technologies in Europe], and other computer-related projects. Since the start of ESPRIT, ERCIM's three founder members have participated in 65 projects, either as individual organizations, or jointly with other ERCIM members, or with partners from science and industry.

ERCIM now plans to promote closer cooperation on research work under joint projects. At present, ERCIM is already coordinating the proposals submitted in response to its various invitations. Special attention will be devoted to the following areas of research, which are currently regarded as being of the greatest long-term benefit to Europe:

- Basic principles of computer science: theory of parallelism, specification, transformation and verification procedures, and artificial intelligence and neural network programming procedures;

- New computer and system architectures including special-purpose, distributed, multiprocessor, and massively parallel architectures;

- Methods, algorithms, languages, and architectures for the use and application of computers in, for example, scientific computing, automatic control, signal processing, image processing, computer vision, robotics, and information and data base systems.

Within these three areas, ERCIM focuses on projects that:

- Require the complementary cooperation of experts from the individual organizations to achieve a synergetic effect;

- Strengthen the European market and promote science, training and standardization;

- Further benefit each member organization and its community of research workers through the joint exploitation of resources.

ERCIM's Organizational Framework

Basically, the aspects of ERCIM's work described so far have been undertaken by the members without waiting for funding from external sources. The EC-funded projects are an exception. This approach has enabled ERCIM to hold down administrative costs while acting and implementing results rapidly. So far, ERCIM has invested annually an estimated ECU100,000 in joint project-related personnel and infrastructure measures.

ERCIM is organized in accordance with the agreement on scientific cooperation signed by the directors of the member organizations on 13 April 1989. Under this agreement, the directors meet twice a year to decide on ERCIM's priority topics and to agree on future strategies. A standing committee is responsible for the implementation of joint initiatives. Its member are made up of two scientists from each member organization and the heads of their international departments. They carry out their work at various meetings, through extensive use of electronic networks, and via special working parties.

This loose organizational framework has been fine for three-member organizations but an increase in membership will make things more difficult. For this reason, ERCIM is seeking to create a more formal organizational and legal framework that will enable it to achieve its objectives.

ERCIM's Future Role

In my opinion, ERCIM must work constantly to enhance its role in the EC Commission, in the European and non-European scientific community, and in industry.

As regards the EC Commission, ERCIM's members believe that the consortium "could create a platform and the infrastructure required to prepare the ground for decision-making and to take account of the reactions and opinions expressed by research workers and scientists with a view to achieving a consensus." ERCIM's computer network and infrastructure make for speedy decision-making.

ERCIM is in a position to exploit its members' industrially neutral know-how, help evaluate information technology-related programs and projects, and predict their potential impact from a scientific point of view. As the European scientific community is made up of many

different research institutes and universities, ERCIM could become a forum for academic interests and those of other research centers serving the common good. It could also serve as an advisory body with regard to the exploitation of information technology know-how by the EC.

ERCIM's participation in various ESPRIT projects and other complex projects, whether under EC programs or not, makes it the ideal organization to head complex projects and subprograms in specific areas of information technology.

Future Prospects

The experience that we have acquired over the last two years is highly positive and encouraging. We thus expect ERCIM to make its voice heard on basic research topics in the European Community. ERCIM should also take a stand on developments in advanced training and on the quality and impact of long-term funding programs at the European level.

To achieve all this, ERCIM could regularly draw up a sort of white paper on computer science assessing the current state of the art and issuing guidelines and strategies for the future from a scientific viewpoint.

ERCIM must strengthen its existing links with the community of scientists at European universities and bring these links into play at European level. When we invite other European research institutes to join ERCIM, we should also be thinking about closer cooperation with eastern European partners. Intensive support for international conferences, workshops, and symposia could be a first step in this direction.

Most importantly, it is essential that we develop widespread public awareness of a real scientific community in Europe. Every research worker on this continent must feel free to contact a European colleague for advice, even if he lives 2,500 km away. In this respect, ERCIM could make a significant contribution by, for example, helping to organize European conferences on information technology.

These are just a few suggestions as to how ERCIM could promote wider international cooperation. One thing is certain: All our endeavors are now based on a solid European foundation in computer science and information technology. ERCIM and other organizations will benefit the European Community as part of a global society.

DEFENSE INDUSTRIES

Aerospatiale Finances, Projects Reported

91MI0165 Duesseldorf HANDELSBLATT in German 11-12 Jan 91 p 17

[Text] Henri Martre, chairman of the board of the French military technology concern Aerospatiale, has denied rumors that the Daimler subsidiary MBB [Messerschmitt-Boelkow-Blohm] intends to withdraw from the European space shuttle program HERMES. Martre told newsmen in Paris that these rumors are unfounded.

According to its chairman, the state concern is still interested in developing an aircraft to complete the lower end of the Airbus range with a new 80 to 130-passenger model as a member of a European consortium that will also include MBB. No concrete decision has yet been made in this respect, nor, in all probability, will there be one unless Aerospatiale succeeds in acquiring the Canadian Boeing subsidiary De Havilland.

A new European combat helicopter, the NH-90, to be built jointly by Aerospatiale, MBB, the Italian company Alema, and the Dutch company Augusta, is also planned. According to Martre, this helicopter will cost 1.4 billion European currency units [ECU] to develop, of which Aerospatiale will contribute ECU607 million, Alema 367 million, the German partner 331 million, and the Dutch partner 92 million. The project awaits approval by the governments concerned.

The Aerospatiale chairman was very cautious as to the economic consequences that the Gulf crisis would have on the company. Owing to sanctions, 100 tactical military aircraft and about 100 helicopters, for which firm orders had been placed, could simply no longer be delivered to Iraq. In the past Iraq had been one of the concern's most important foreign customers. According to reliable estimates, Iraq is indebted to French arms suppliers for well over $6 billion.

The concern's overall income increased only slightly to over 32 billion French francs [Fr] in the 1990 financial year, as against Fr31.7 billion in the preceding year. This stagnant trend was caused, he said, apart from the weakness of the dollar, by events in the Gulf. As in recent years, the quantative growth rate was around ten percent. The overall sales target for the current financial year is around Fr40 billion.

Granted, orders booked in 1990 did not reach the record Fr83 billion of the previous year, but at Fr55 billion they were about Fr5 billion higher than the company's planners had foreseen. At Fr120 billion, orders booked by year-end were up on the Fr90 billion achieved by the end of the previous year. The company's order books are full for three whole years, with a particularly marked increase in the aerospace sector. Business has declined in tactical military aircraft. Exports accounted for 66 percent of the orders booked and 60 percent of income, i.e., Fr20 billion.

In 1990, investments in material assets increased slightly to Fr2.3 billion as against the previous year's Fr2.1 billion. Investments amounting to Fr2.6 billion are planned for 1991. The lion's share of this sum will be spent on modernization. The new production facilities for the main stage of the new Ariane-5 rocket will be inaugurated in the current year.

Aerospatiale spent Fr12.5 billion on research and development in 1990,

12 percent more than in the preceding year, financing Fr2.8 billion of this amount from its own funds. The research budget amounts to 35 percent of total income, which, the chairman explained, puts the company at the very top of the world league in military technology.

The company's productivity made further progress last year, achieving the goal of Fr1 million income per employee set a few years ago. Factors of uncertainty in the current year remain the Gulf crisis, whose outcome cannot be predicted, and currency instability.

Italy, France, UK To Develop Radar Guidance Systems

91MI0145 Rome AIR PRESS in Italian 5 Dec 90 pp 2229-30

[Text] The agreement signed by Selenia, GEC-Marconi, and Dassault Electronique is the logical "followup" to the Italian-French agreements on the FSAF (Future Surface-To-Air Family) missile program. In fact, the new agreement involves radar guidance systems ("seekers") and is directly related to the Aster missile project, which is part of the FSAF, and whose active radar guidance system Selenia and Dassault Electronique are already working on. The agreement also broadens the scope of the accord between Dassault Electronique and GEC-Marconi in the sector of "seekers" for short-range, air-to-air MICA [Interception and Air Combat Missile] missiles which paved the way for the already hypothesized inclusion of the UK in the Italian-French agreements. It is just as likely that Spain, too, will join the program. Spain is eager to join Eurosam, the Selenia, Aerospatiale, and Thomson-CSF consortium, which is responsible for the development of both surface and sea FSAFs, even though the share of its participation are still to be defined. The Spanish company Ibermisil and the UK's Marconi and British Aerospace joined Eurosam last July with a view to negotiating a contract, to be signed by the end of 1990, for the definition of a "local" area missile systems project (LAMS), primarily intended for the Spanish and British Armed Forces.

The new French-British-Italian agreement involves the joint development, manufacture, and marketing of "seekers." According to a joint statement released by the three companies, it is designed to improve performance and results through technology transfer, eliminate a duplication in R&D activities with a resulting reduction in costs, broaden the range of prospective applications and, finally, enhance systems standardization and interoperability among the allied forces. The fact that the statement ends by saying that said agreement "may be extended to other companies or divisions of the same sector" refers implicitly to the arrival of another partner, and everything seems to suggest that it could be Spain.

Selenia's agreements with European partners demonstrate that the desire of this IRI [Institute for the Reconstruction of Industry]-Finmeccanica company is to gain access to the large international consortia that are being established in Europe for the new European army defense systems of the near future. This desire is also evident in the civil sector such as air traffic control, where the IRI-Finmeccanica company has established the Buran joint venture company with the Soviets.

Eurosam, which is the outcome of the Italian-French bilateral cooperation agreement signed in October 1988, is a GIE (Groupement d'Interet Economique) based in Paris. It was first established in June 1989 by Selenia, Aerospatiale, and Thomson-CSF for the development of ground and naval surface-to-air missiles that are designed to respond to the hypothetical air and missile threat (including antiradiation and sea-skimming missiles) of the 21st century. On 22 May 1990, Eurosam was assigned a 10.2-billion-French francs [Fr] contract by DGA (Delegation Generale pour l'Armement), the French general armaments board. The sum, equally divided between Italy and France, will be used over the next 10 years to develop the surface-to-air and sea-to-air versions of the FSAF, a "family" based on the Aster missile, which constitutes the FASF's ammunition.

Aster is a supersonic missile with a two-stage engine, that can attack multiple targets coming from all directions under all weather conditions thanks to the system's sophisticated devices: multifunction radar, active missile guidance in the final stage, vertical launch, a high level of resistance to electronic disturbances. The most innovative feature of Aster is its dual control system, developed to achieve a higher level of agility and maneuverability than the current generation of surface-to-air missiles. The missile features an aerodynamic control system and a second system which, through hot gas jets, corrects any errors made by the first.

The FSAF comprises three medium-range missile systems that are based on common elements and have been adapted to specific roles: SAAM (Surface-to-Air Anti-Missile) for targeted naval defense; SAMP/N (Surface-to-Air Missile Platform/Naval) for wide area naval defense; SAMP/T (Surface-to-Air Missile Platform/Terrain) for ground defense. All of the three systems share the following features: modular vertical launcher, X-band ARABEL multifunction planar antenna, C-band EMPAR (European Multifunction Phased Array Radar) radar, MARA (Modular Architecture for Real-Time Applications) computer, and MAGICS (Modular Architecture for Graphic and Image Console Systems) display systems in addition to control and monitoring programs using ADA language. Industrial production is expected to begin in 1993 while the first FSAF systems should be operational by 1997.

ENERGY

Biogas Plant Described

91AN0178 Stockholm NEW SCANDINAVIAN TECHNOLOGY in English No 4, 1990 p 7

[Article: "Rubbish Turned Into Biogas"]

[Excerpts] In Hillerod, Denmark, an interesting facility for thermophilic anaerobic compostion has been taken into use. The experimental plant was developed by a Danish engineering company, I. Kruger AS, in cooperation with the power company IFV-energi I/S and the municipality of Hillerod.

This is a pilot plant with capacity to treat some 1,000 kg/day of source-sorted waste. The optimal process conditions are now being investigated in a series of trials in Hillerod.

While aerobic compostion of the organic portion of rubbish is a method that has been used for many years, there are very few facilities in the world that have tested anaerobic technology.

The anaerobic technology is interesting in that the process forms gas containing 50-60 percent methane. The energy content of this biogas can help to achieve good operating economy for the plant.

In this project, Danish technology for anaerobic composting has been developed for the purpose of generating source material as a basis for future full-scale facilities. The project is expected to cost some 15 million Danish kroner and is being backed by the Danish Environment Board insofar as rubbish collection is concerned. [passage omitted]

The biogas plant in Hillerod consists of four sections, one for pretreatment, one for processing, one gas system and one air treatment section.

The pretreatment section features a reception station for organic waste, a sack cutter, a sorting and homogenization drum, and a magnetic separator.

The process facility consists of a silo, a biogas reactor, a biofilter, a press for degassed material and a collection tank for reject water.

The gas system features a gas container with a gas motor and generator unit.

The air treatment plant consists of composite filters for elimination of foul odours.

The biogas facility is also furnished with comprehensive measuring equipment and the results of the various measurements are processed electronically every day. The entire plant is automated, so that in normal daily operation manual intervention is necessary for only a few tasks.

Several different processes are being tested in the facility in order to determine the most optimal process conditions.

According to the time schedule, the process experiments will continue throughout 1990 so that evaluation and establishment of a full-scale facility will be able to take place as from 1991.

FACTORY AUTOMATION, ROBOTICS

Siemens Develops New Robotic Control Unit

91P60116 Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 14 Jan 91 p 10

[Text] Siemens AG, Munich/Berlin, has developed a new robotic control unit, the Sirotec RCM 3D. The device reportedly reduces reaction times to sensor signals to 40-50 milliseconds as well as overall batch processing cycle times. While increasing the number of functions managed by the device, Siemens was able to reduce the device's modules to two CPU modules based on the 80186 microprocessor and having a 16 MHz cycle time. Each CPU module is equipped with a replaceable EPROM module. By optimizing the device's regulatory structure, Siemens has also managed to reduce mechanical wearand-tear while improving the on-track behavior and contour precision of robotic systems. The device is operated by a user control panel. For added safety, the control device is equipped with a three-position permissive switch to govern the movement of a robotic system. If this switch is disengaged or forced, all robotic system drives shut down immediately. Siemens anticipates that the Sirotec RCM 3D will open up new avenues for the application of industrial robotics.

LASERS, SENSORS, OPTICS

Industry Uses Capacitive Sensors as Measurement Tools

91WS0188A Paris L'USINE NOUVELLE/ TECHNOLOGIES in French 17 Jan 91 pp 11-12

[Article by Marc Chabreuil: "Industrial Feats of Capacitive Sensors"; first paragraph is L'USINE NOUVELLE/ TECHNOLOGIES introduction]

[Text] Their high accuracy of measurement without contact, and "impossible" missions, have opened for them the doors of industries in sectors ranging from the mechanical to the nuclear.

While military aviation demands powerful turbojets, civil aviation puts its priority on efficiency. In both cases, the spacing between turbine blades and casing is determinative. But knowing that the turbine turns at 43,500 rpm and that the temperature exceeds 1000 degrees C, the measurement of this spacing appears to be impossible. Tests have been run successfully, however,

on a Turbomeca-built motor. And an Alfa Romeo-built jet engine is currently being equipped with measuring instrumentation (20 test channels and 300,000 measurements per second) by Fogale Nanotech, a Nimes-based PMI [Small and Medium-Sized Industry] specializing in capacitive dimensional metrology.

This technology was developed by ONERA [National Office for Aerospace Studies and Research] for the CACTUS [Ultra-Sensitive Triaxial Capacitive Accelerometric Sensor] program. With it, ONERA gained (and held on to) a considerable lead worldwide, a lead that Nanotech, licensed by ONERA, has been able to exploit: first, by mastering new principles of conversion between capacitance and potential. Then, by the use of serigraphy and CVD [chemical vapor deposition] to achieve perfect dimensional stability while reducing physical volume.

Thus was born a line of industrial products whose precision (down to the nanometer) is 10 times greater than that of competing products, and whose measurement noise factor is better than 10^{-6} pF/Hz. The latest such product is an integrated sensor 20 mm in diameter by 60 mm in length. With a precision of 1 micron, a repeatability of 0.1 micron, and a passband of 1000 Hz, it provides a measurement range of 1 mm. It will be manufactured jointly with the Marposse company, to the extent of 10,000 units, and sold at less than 8,000 francs per unit, a price close to that of an inductive system.

"Our capacitive sensors enable measurements that are impossible using other technologies: cylindrometry, subnanometric resolution in a harsh environment... They respond to the heretofore unfulfilled demands of industries," says Jean Leteurtre, the founder of Nanotech. "They are suited, in fact, for measurements of displacement, thickness, vibrations, alignment, concentricity, eccentricity, etc... And all of these without contact and on a fully-continuous basis." Such sensors have been used at Michelin, for example, to measure to the 1/100th the thickness of rubber "banding strip" heated to 150 degrees C, and of aluminum at Pechiney.

The first applications were on a high-technology scale. Nanotech systems were used by EdF [French Electric Power Company] to measure, within plus-or-minus 5 microns, the circularity of nuclear power plant exchanger tubes and to check their in-process expansion at intervals of 1 millisecond. They have also been used to test the quality of the valves produced by COGEMA [General Nuclear Materials Company]. At the Grenoble synchrotron, 300 of these units will also be found monitoring the horizontality of the ring. This application opens the way to continuous measurement of the settings of large-sized machine tools. In addition to the measurement sector (Rank Taylor Hobson plans to integrate Nanotech sensors, accurate to within 0.01 micron, with its roughness measuring equipment), the mechanical sector is one of those with a primary interest in this technology, in that it enables in-process measurement of workpieces during machining. At the Francaise de Mecanique plant, a Renault Automation prototype is being used to turn piston skirts with four bosses. Controlled by a "blower sensor" that deflects the water, oil, etc, the cutting tool is moved 4 mm every millisecond to machine these protuberances. Studer is preparing a new generation of so-called "controlled grinding" machines. AGIP [National Italian Oil Company] is using this technology to check the shape of oil-well drill-pipe welds... Bosh could use Nanotech products for submicronic measurements on the 80,000 injectors it manufactures daily. Jean Leteurtre has hired two "Cifre" engineers to reduce the size and manufacturing cost of his sensors, and plans to put a system on the market, in the very near future, for continuous measurement of the moisture content of solids. His objective: cement works, plaster works, and, principally, the agricultural food industry.

[Box, p 12]

Aerospace Fallout

Nanotech sensors had their origin in the know-how acquired by ONERA under the CACTUS program. Launched into space in 1975, CACTUS enabled the drawing up of the terrestrial gravity field map needed to ensure the accuracy (100 m) of strategic missiles. CACTUS contained a platinum-rhodium sphere weighing 600 g and measuring 4 cm in diameter, suspended within a spherical cavity, under the influence of three electrostatic forces of attraction. The interval was 85 microns. Displacement of the sphere (10 microns at maximum) was detected by sensors (0.1 micron resolution), each of which, together with the sphere, formed a capacitive bridge. Electronic processing systems measured the relative position of the sphere with a resolution of 0.001 micron. (The prototype of the Gradio accelerometer improves on this by a factor of 1000!)

Stemming directly from this technology, Nanotech's first capacitive measurement bridge exhibited identical characteristics: a measurement noise factor of 10^{-6} pF from 0 to 20 kHz.

Germany: Integrated Optoelectronic Safety System Described

91WS0084A Berlin FEINGERAETETECHNIK in German Nov 90 pp 509-513

[Article by W. Koch and R. Miller of Preussag AG, Hanover, "Integrated Optoelectronic Safety System for Harsh Environmental Conditions"]

[Text] A safety system for the testing of fiber-optic sensors has been set up on an offshore oil platform since 1987. The technical advantages of using fiber-optics in offshore environments and in processing systems are insensitivity to electromagnetic interference, inherent safety and, in the future, when electrically passive fiber-optic sensors (FOS) that can be multiplexed optically are available, a reduction in cable diameter and weight. During the test and installation phase, the sensors were first ordered or were developed based on existing sensors or sensor components. The tests were then carried out in

the laboratory. In a field test on an offhsore platform, sensors that passed these tests were set up in parallel with the existing monitoring systems. This test will provide us with a multitude of answers to questions regarding how optical fibers and fiber-optic sensors can be used in problematical and harsh environments.

1. Why Fiber-optic Sensors for Offshore Applications?

At present, the safety standards on offshore oil and gas platforms (Figure 1) are already very high; however there is still a certain risk involved. The complexity of the tasks involved in process monitoring has increased, and the observed trend has been to use analog rather than simple digital sensors. The number and size of the platforms for a single oil field has also increased. This has led to process monitoring systems that entail 10,000 inputs and outputs.

Following a number of very serious accidents, careful consideration was given to reducing the potential hazards to the employees and to the environment by increasing the reliability and performance of systems and system components and by strictly separating the production systems from the living quarters. Naturally, the reliability of the equipment on an oil platform also requires consideration with respect to false alarms. If a false alarm is not recognized as such, it can cause the process to shut down. A shutdown lasting only a few seconds can mean the loss of a million dollars or more.

Table 1. Particular Advantages of Fiber-Optic Sensors for Use in Harsh Environments

Insensitivity to Interference
- Electromagnetic interference
- Crosstalk in signalling lines
- Corrosive environment

Application Potential in Explosion-Hazard Areas
- Signal transmission and power supply with low light energy
- Low light energy, thus reduction of cable cross-section with inherent safety
- Enormous broadband pontential
- Low fiber weight

Result
- High reliability
- Few false alarms

The average failure rate of a process monitoring system is a function of the average failure rate of the individual sensors (and other parameters). How to improve the reliability of the sensors must therefore be given consideration. Using the test system described, we are in the process of discovering how the promising field of fiber-optic sensor technology can improve the reliability of a monitoring and safety system in a difficult and harsh environment.

Table 1 shows a number of properties that make fiber-optic sensors and systems advantageous for applications under difficult conditions such as those that can exist in the offshore industry. In this report, the offshore industry is presented as one of the most difficult environments that can be encountered. The range of applications can therefore be expanded to include applications encountered on ships or in the chemical industry.

2. The Structure of the System

An integrated optoelectronic safety system for offshore use (OESS) was planned during a market research and definition phase.[1]

Components of this system were tested in the laboratory. A two-year field test began in the summer of 1989 on a relatively small offshore oil platform with a minimum of processing equipment and instrumentation—production platform A in the Schwedeneck See offshore oil field of the consortium RWE-DEA Aktiengesellschaft fuer Mineraloel und Chemie/Wintershall AG (see Figure 2). The system described is present in addition to the platform's safety and monitoring system, which has a very high safety standard and is not affected by the field test. The OESS system is subdivided into the subsystems fire prevention and gas detection, process monitoring, platform monitoring, and monitoring of environmental parameters. As shown in the system block diagram (Figure 3), which depicts all of the testing tasks originally desired, we distinguish the following zones on the platform:
- processing area
- explosion-hazard zone I
- platform deck
- workshops
- platform stem
- production sensors

This figure represents our extensive considerations that were reduced to the sensor system as described in section 3.

3. The Sensors

Finding high-quality sensors for this system was not easy. Approximately 600 firms all over the world are engaged more or less heavily in fiber-optic technology, but relatively few sensors are commercially available as prototypes—a very small number as fully developed products.[1,2] In the meantime, many firms have halted their fiber-optic sensor activities, because they had underestimated the amount of labor required to convert simple transducers, e.g., switches, to fiber-optic technology.

As Figure 3 shows, many sensor tasks were considered. For some of them—the ice-drift sensor and the well hole sensors, no fiber-optic sensors could be found. A few extremely expensive sensors were not tested during the initial test phase: a hydrophone for intrusion monitoring and pipeline monitoring; a cable monitoring device for continuous temperature monitoring over a great distance, and an oil-in-water monitor. A few others—a smoke detector, a load sensor for concrete structures and a vortex liquid flow counter—were no longer available, in one case apparently due to technical problems and in

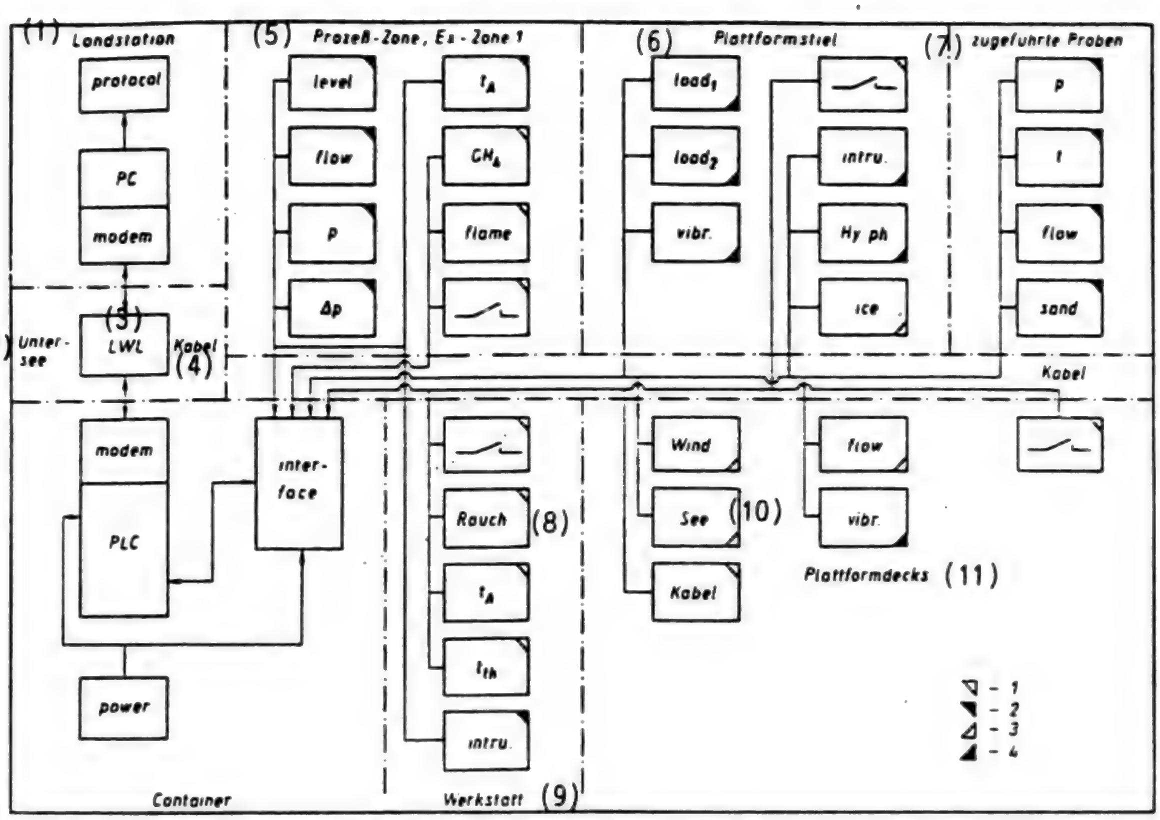


Figure 3. Integrated Optoelectronic Safety Ssytem for the Open Sea (1 Fire Prevention, 2 Gas Detection, 3 Environmental Monitor, 4 Platform Monitor: intru. = intrusion, Hy.ph. = hydrophone)

Key: 1. Land-based Station—2. Undersea—3. Optical Waveguide—4. Cable—5. Processing Zone, Explosion-Hazard Zone 1—6. Platform Stem—7. Samples Entered—8. Smoke—9. Workshop—10. Sea—11. Platform Decks

two other cases due to marketing considerations (and probably unexpected technical problems encountered during prototype testing).

The sensors currently under test are listed in Table 2. This table gives an extract of information intended to provide an idea of the distance neutrality and the resistance to cross-sensitivity, as well as the possible structure of a network architecture for a fiber-optic sensor system. Very few principles employ Monochromacity, and no single-mode fiber is used. In general, the rule is to use robust solutions, not fascinating solutions that exist to date only in principle.

Most sensors characterized here as prototypes still require a minimum of engineering effort, if not more, before they can be used in an industrial process, particularly if the application under consideration is in safety-related areas such as the offshore or chemical industries. Some of these sensors are still so much in the prototype stage that they do not come into consideration for a field-test installation.

The fact that the fiber diameter differs from sensor to sensor can be said to be typical of the current state of the art. In general, not even fiber properties such as numerical aperture and optical windows are the same for fibers of the same diameter. This makes setting up a system problematical. Moreover, fibers from different manufacturers must be broken differently. The tools for making connections differ between different types of fibers and between different types of plug-in connectors (sometimes even between the same "standard" plug-in connectors). This means that a company that provides instrumentation and installation for a fiber-optic system must have a great deal of practical experience in this field of applications. The reduction aspect with respect to cable cost and weight as a result of the high bandwidth potential was not considered with the sensors investigated. We found only one network for switches that permitted optical multiplexing and that could be improved by further development of the hardware and perhaps the addition of a microcontroller. In the area of communications, on the other hand, intensive effort is taking place with respect to LANs.

4. Fiber-Optics Under Extreme Environmental Conditions

The major advantages of fiber-optic communications with respect to transmission properties are undeniable.

The installation and fabrication of fiber-optic components, on the other hand, is problematical, and in some areas these problems have not yet been solved or adequately researched. This is particularly true with regard to their use under extreme industrial conditions. At present, it is not always possible to obtain fiber-optic components suitable for industrial use at reasonable prices and with reasonable delivery times; this applies especially to fiber-optic measurement systems, cabling, special fibers and special plug-in connectors.

Offshore environmental conditions are probably among the harshest encountered in industry. In addition to optimum technical data, components used there should generally meet the following requirements:

—broader temperature range of -40°C to +85°C
—large transmission distance
—insensitivity to EM fields
—inherent safety
—corrosion resistant
—resistant to saltwater, oils and other chemicals
—water-tight design
—flame-resistant, self-extinguishing, halogen-free design
—shock and vibration resistant
—generally robust, highly impact resistant, flexural strength
—easy to install and replace
—appropriate price/performance ratio

The use of fiber-optic technology in industrial process engineering requires components that meet these difficult requirements. This is true both for the material used and for the installation methods. The use of fiber-optic components in industry requires special knowhow and methods; if not handled competently, this technology can lose its advantages and lead to totally unreliable results. The following decision-making criteria can be applied as a basis for selecting suitable optical waveguides and cables, as well as suitable connectors:

—price
—availability
—ease of handling
—compatibility
—attenuation properties
—temperature range
—tensile strength and aging
—behavior in case of fire

5. Aspects of a Safety and Monitoring System

Since the OESS system described here is to be constructed as part of a safety and monitoring system, some rules and standards relevant to safety, reliability and applicability in the offshore industry must be adhered to.

There is a strict separation between the so-called "Emergency and Shutdown System," on the one hand, and the safety system and the monitoring system, on the other hand. All three systems must operate independently of one another. On the other hand, process parameters controlled by a process monitoring system, such as pressure in a tube, are naturally safety-related and must therefore also be evaluated by a safety system. Such important parameters must be carefully monitored. Therefore, redundant measurements must be taken, and they must be monitored in a two-out-of-three configuration, for example. If a parameter must be monitored with triple redundancy, the three lines must not be combined within a single multiplexer. This increases the complexity and the material cost of a safety system.

Table 2. Sensors Used in the Test of the OESS System

Measurement	Physical Principle	Fiber	Status
Temperature	Photoluminescence	600 μ	Prototype
Temperature	Fabry Perot	100 μ	Mass-produced
Temperature	Wax Fouling	200 μ	Prototype
Flame	IR Detector	Bundle	Mass-produced
Pushbutton	Diaphragm	200 μ	Mass-produced
Pushbutton	Mirror	1mm, poly	Mass-produced
Pushbutton	Mirror, FO Network	100 μ	Prototype
Methane	Absorption +	200 μ	Lab
	reference waveg.		prototype
Liquid level	Refractive index	200 μ	Prototype
Liquid level	Refractive index	100 μ	Prototype
Liquid level	Evanescent wave	100 μ	Prototype
Pressure	Special OTDR	200 μ	In development
Differential	FO smart sensor	200 μ	Prototype
Pressure			
Vibration	Distance	200 μ	Prototype
Angle of rotation	Sector diaphragm	1mm, poly	Prototype
Angle of rotation	Sector diaphragm	100 μ	Prototype
Angle of rotation	Sector diaphragm	100 μ	Prototype
Light barrier	Intensity	600 μ	Prototype
Safety mat	Microbending, intensity	50 μ	Mass-produced

On the other hand, reducing cable weight and length reduces costs, both directly and indirectly, due to the low material requirements for the mechanical structure of a platform (or ship). This fact should be given consideration by placing greater emphasis on the development of fiber-optic sensors for sensor networks. Much more effort should be concentrated on this aspect.

When fiber-optic sensors are to be used in a process monitoring system in the oil or chemical industries, for example it must be ensured that the light energy input into the fiber is not so great as to produce an ignition hazard. Some basic investigations have been carried out which address the basic problems and provide information on how such an effort should be carried out.[4] However, several man-years would be required to complete such a task. Since definitive limit values are not available, a situation arises in which unofficial (de facto) or official, national authorities have enacted different, very strict limit values just to be on the safe side.

Even today, no one is really sure whether the definition of a few mW/mm^2 of irradiance or 1 mW within a given fiber is realistic or perhaps an order of magnitude too strict. Companies and national governments that support projects for fiber-optic sensors should consider whether this important task ought to be carried out soon.

6. Development of a Fiber-Optic Accelerometer

Discussions between the platform operating company and Preussag led to the development of a new accelerometer. The platform operating company was interested in objective data of a quantitative and qualitative nature regarding the vibrations to which the platform is exposed as a result of the special environmental conditions.

A robustly designed fiber-optic accelerometer was thus developed for offshore use. Servo-accelerometers are used conventionally to measure the slow natural vibrations that occur when structures such as oil platforms are exposed to the effects of wind and waves. The problem with such sensors is that they are often difficult to install, e.g., due to the triboelectric effect in cables. They are also sensitive to the strong electromagnetic fields that occur on platforms. Universal applicability is important if vibrations at different points within a structure are to be analyzed.

A sensor has been developed that not only overcomes these problems due to its electrically passive operating mode but is also suitable for other applications, including monitoring the vibrations of large structures such as bridges and towers. The use of these new sensors will enable civil engineers and structural steel designers to decide whether material fatigue is to be expected and will permit greater understanding whenever structures are to be built for maximum safety without unnecessary expense.

The currently installed accelerometer uses two sensor heads that can sense orthogonal displacement along the vertical and horizontal axes at the same time. However, the system can easily be expanded to three or four axes. The sensors are combined in an array that is installed on the platform and transmits information to a transceiver via robust fiber-optic plug-in connectors and lines. Due to the thermal neutrality of the configuration of mechanical and optical axes of symmetry of the measurement transducer, very reliable measurements are possible over a large temperature range. During laboratory tests, it was found that the sensor is extremely insensitive to temperature changes in the range of -30°C to +60°C.

7. Tests in the Laboratory

The laboratory tests and the testing of the fiber-optic measurement systems are used to determine offshore usability and to check manufacturers' claims. These investigations are necessary because in practice the technical data actually obtained sometimes deviates from that of the manufacturer, due to an insufficient level of development, for example. With prototypes or products from small lots, in particular, there can also be design errors that make these devices unsuitable for industrial use. The tests are particularly important regarding monitoring devices in safety systems such as strain, gas, flame and smoke detectors. With these kinds of sensors, the actual occurrence of a recordable event is not necessarily expected during the field testing phase on the production platform. Moreover, the test results should allow comparisons between the fiber-optic measuring devices of different manufacturers. The laboratory tests were categorized as follows:

Test Program 1: Performance Tests
- —Measurement principles and procedures
- —Design and modules
- —Test range and testing errors
- —Sensitivity and resolution
- —Stability and linearity
- —Dynamics
- —Cross-axis sensitivity
- —Control and evaluation electronics
- —Power supply—Service

Test Program 2: Fiber-optics and Optoelectronics
- —Power distribution
- —Light source
- —Input/output optics
- —Coupling methods
- —Connection path
- —Detector

Test Program 3: Environmental Simulation
- —Effect of temperature
- —Effect of temperature/humidity
- —Shock and vibration
- —Electromagnetic compatibility
- —Special atmospheres

Within the scope of the overall project, basic laboratory tests were first carried out to assess usability and to determine the technical and optical properties. Results to date show that well functioning systems are available now; development work is still required with some systems in order to raise them to an industrial standard. Unfortunately, we also investigated systems that have serious design flaws or that, due to their poor level of development, cannot be considered for use at this time.

The test series showed that the deciding factors regarding usability of fiber-optic measurements systems were as follows:

—Performance

—Optical engineering (distance neutrality, optical power distribution)

—Mechanical engineering (assembly and interconnection methods)

—Assembly of electro-optical transducer unit

—Materials used

The same applies by analogy to fiber-optic components and coupling methods.

The laboratory test results for those fiber-optic measurement devices completely tested to date are summarized in Table 3. In addition to problem-free operation, the baic criteria used here were distance neutrality, the transmission distance achieved, the failsafe response and the ability to meet explosion protection requirements. Systems given two or three stars were included in the field testing; systems with one star were not given further consideration or are still being appropriately modified.

Table 3. Test Results for Fiber-optic Sensors

Measurement	Principle	Transmission Distance	Failsafe[1)]	Explosion Zone	Distance Neutrality	Result
Temperature switch	on/off	100 m	yes	no	Opt. performance	++
Flame	on/off	20 m	yes	yes	IR detector	++
Pushbutton	on/off	2 km	possible	yes	Opt. performance	+++
Pushbutton	on/off	2.5 km	yes	yes	Opt. performance	++
Network of switches	on/off	3 km	yes	no	OTDR	++
Methan	analog	1 km	yes	yes	Reference wavelength	++
Thermometer	analog	100 m	possible	yes	Time range	+++
Thermometer	analog	2 km	possible	yes	Interferometer	++
Pressure	analog	1 km	yes	yes	Interferometer	+++
Differential pressure	digital	3 km	yes	yes	Hybrid	+++
Liquid level	on/off	100 m	yes	yes	Opt. performance	+
Liquid level	on/off	200 m	yes	yes	Opt. performance	+
Liquid level	on/off	100 m	possible	no	Opt. performance	+
Light barrier	on/off	500 m	yes	yes	Opt. performance	+++
Safety mat	on/off	1 km	yes	yes	Opt. performance	++
Accelerometer	analog	500 m	yes	yes	Displacement	+++
Angle of rotation	digital	100 m	no	yes	Opt. performance	+
Angle of rotation	digital	3 km	no	yes	Opt. performance	+++

Result +++ usable;

++ limited usefulness

+ unusable

1) automatically generated hen fault message does not arrive

Other investigations in the laboratory were related to the fiber-optic components used, since their properties can have a crucial effect on the measurement systems. In this regard, tests of distance neutrality were performed with respect to bending, temperature, saltwater mist, humidity, pressure, and cabling and coupling methods. Problems or serious deficiencies were found with numerous coupling components, e.g., connectors, splices, couplers, cables and optical waveguides. In general, it can be said that these components must be selected very carefully in order to obtain reliable systems.

8. Offshore Test Phase

The field test on the platform is performed in order to verify whether the theoretical considerations and the laboratory tests have resulted in practical solutions for the system, as well as for the sensors and components. The key concept is long-term stability.

An extremely important aspect is the installation of cables and sensors. Work on an offshore platform is very expensive. In order to save money, each individual installation procedure must therefore be carefully

planned. However, cable cannot be cut to suitable lengths and provided with plug-type connectors ready for installation. As soon as a sensor is installed, tests are performed in order to simulate events, e.g., an increase in temperature or the presence of methane. The area on and around the platform will expose the system to other environmental influences such as vibration due to icing, cold, ice, heat, as well as salt precipitation and humidity as disruptive factors. We hope that cable will not break during the test phase, but we must be prepared for it. Splicing in an explosion-hazard zone or in an atmosphere of -20°C means taking special precautions.

9. Summary

It was possible to find a few very promising prototypes and small-series products at the present stage of technological development. The purpose of the projects presented here was to find out the stage of development of this sensor technology. We can only report on sensors outside of the military sector.

At present, fiber-optic sensors are a technology for a few market niches and should continue to be developed in such a way that they can survive under their typical environmental conditions. We did find good-quality sensors. These sensors could become part of a safety and monitoring system in a difficult and harsh environment. Others could be used on one or two components following a certain degree of engineering work. Despite all the criticism, it must be said that developers of fiber-optic sensors have learned something in the past few years, e.g., fiber-optic switches were improved over earlier stages of development, even if they are not yet perfect in every respect.

We expect a technological leap in fiber-optic sensor technology with the introduction of integrated optics.

Networking capability would make fiber-optic sensor systems much more attractive for use in a process monitoring system. A great deal of work has already been done on this subject in the military sector, but sensor networks for the civilian process monitoring market still require more development effort.

References

1. H. Amann, W. Koch and R. Miller, Integriertes Opto-Elektronisches Sicherheitssystem Offshore/Definitionsphase (Integrated Opto-electronic Offshore Safety System/Definition Phase), Final Report to the MBFT, Hanover, 1988.

2. Overview Assessment and Project Definition Study for the Application of Optical Sensors and Optical Fibre Technology for Offshore Structures, Battelle Geneva Research Centres, Geneva, 1988.

3. N.T. Friedrich, Linking LAN's With Fiber: Cost and Other Factors, PHOTONICS SPECTRA, No 9, 1989, p 89.

4. G. Tortoishell, Safety of Fibre-optic Systems in Flammable Atmospheres, Fibre-optics '85 Conference Proceedings, London, 1985.

MICROELECTRONICS

JESSI Board Approves Equipment Materials Projects

91AN0160 Amsterdam COMPUTABLE in Dutch 14 Dec 90 p 12

[Article: "Several Projects Are Awarded JESSI Status"]

[Text] Munich—The JESSI Board has approved another series of projects ensuring the further implementation of the "Joint European Submicron Silicon Initiative."

At the board's latest meeting, the green light was given for four new projects under the "Equipment and Materials" subprogram. One of the projects deals with automatic control of the environment of the silicon wafer that holds the chips. Another project examines a new method for cutting wafers with a large diameter in order to produce the actual chips. The third project involves the development of robot modules to handle these wafers. The fourth project concerns the design of resist systems for the fabrication of application-specific integrated circuits (ASICs). A project on future IC packaging technologies obtained the JESSI status within the "Fundamental and Long-Term Research" subprogram.

Within the "Technology" subprogram, a definitive cooperation will be established between JESSI and Sematech, its American counterpart. This confirms the results achieved during recent negotiations. Two other projects in the "Technology" field were also awarded the JESSI status: one on IC reliability and the other on hybrids consisting of various circuits. The withdrawal of Philips from the "Joint Memory Project" was also discussed at the board meeting. It was concluded that the two remaining participants, SNI and SGS Thomson Microelectronics, would have to step up their involvement. Only through increased efforts will it be possible to create the joint technology basis needed for future generations of memory chips. After all, Philips will continue its participation in more than 20 other JESSI projects.

JESSI CAD Project Outlined

91MI0182 Sankt Augustin GMD SPIEGEL in German, Dec 90 pp 40,43

[Article by Elfriede Abel: "Open, Flexible CAD Environments for Microelectronics: JESSI CAD-FRAME Project"]

[Excerpt] [Passage omitted]

JESSI CAD-FRAME Project

The JESSI [Joint European Submicron Silicon Initiative] CAD [computer-aided design]-FRAME project was

launched on 1 May 1990 as the first and central JESSI project on microelectronics applications. This development project aims to create a standard framework for all CAD tools. These include:

- A standard interference for the hardware and the operating system bases;
- Standard design data management, for instance, access control, version management, consistency checks, management on different hierarchical design levels;
- A standard ergonomic user interface that will support dialogue between either an experienced or an inexperienced user and the design system;
- Design system support in the form of, for instance, knowledge-based tool control, design data management on distributed systems;
- Integration support for a wide variety of CAD tools.

In conjunction with these components, a "CAD framework" constitutes an effective software infrastructure for the creation and management of integrated CAD environments. The user is thus free to put together the design system that best suits his purposes without having to depend on a special software and/or semiconductor technology supplier.

Standards and Interfaces

This requires, however, that CAD tool and CAD framework suppliers come to terms on binding standards and open interfaces. European CAD framework suppliers have united under the JESSI CAD-FRAME project both to market standardized interfaces and to create a common CAD framework open to different manufacturers' CAD tools.

The project is closely coordinated with the CAD Framework Initiative (CFI). CFI is a consortium initially of American but now also of European and Japanese hardware and CAD software suppliers and electronics users. It aims to draw up guidelines and standards for CAD environments that will be recognized throughout the industry. The CAD Framework Laboratory (CFL), an independent test center, will verify whether the software offered, which claims to have interfaces as laid down in the CFI guidelines, does in fact conform to them.

Startup Phase

During the startup phase (15 months) the JESSI CAD-FRAME Project will be financed out of EC funds as part of ESPRIT (European Strategic Program for Research and Development in Information Technologies). It consists of the following sections:

- "Applied Research," under which research institutes and universities submit their research results;
- "Framework Development and Support," under which the framework suppliers harmonize their various framework components;
- "Framework Evaluation," under which the users in science and industry examine the framework components proposed and define criteria for future CAD environments from their standpoint.

Through the Requirement Engineering and Future Planning Committee, the participants in the project are jointly drafting the requirements for the planned JESSI CAD framework and working out how to implement it during the main phase of the project (1991 to 1996). The JESSI CAD framework will emerge in a series of graded releases; an initial version will probably be available in July 1991.

Project Participants

The project is supported by all major semiconductor companies including Siemens, Philips, and SGS-Thomson. It incorporates these companies' know-how and exploits the specific experience of companies such as Telesoft and ICL [International Computers Limited], and institutes such as the Technical University of Delft, the Swedish Institute of Microelectronics, and the Computer Science Research Center (FZI) in Karlsruhe. During the startup phase, the major GMD [Mathematics and Data Processing Association] Integrated Circuit Design project will play a part in the definition of future CAD framework requirements. Its role will be to analyze existing procedural interfaces and to integrate GMD-designed CAD tools such as the CTEST test pattern generator and the FEHSIM error simulator with the CAD framework components proposed by way of demonstration. The project is coordinated by CADLAB, a joint venture between Siemens-Nixdorf Information Systems (SNI) AG and Paderborn University.

Key Project for JESSI and ESPRIT

The JESSI CAD-FRAME project will create a common software infrastructure for applications under both the European Community's JESSI and ESPRIT programs. It will thus play a crucial role for all further JESSI and ESPRIT CAD projects on circuit design improvement and software development. It will not, however, be limited to microelectronics but will also support other design automation projects.

ESPRIT Supernode Parallel Computer Project Described

91AN0139 Paris ELECTRONIQUE HEBDO in French 29 Nov 90 p 6

[Article signed P.A.: "Parallel Architectures: Europe Takes Up the Challenge"]

[Excerpts] Supernode, the supercomputer project which is part of the European Strategic Program for Research

in Information Technologies (ESPRIT I), can be considered a success. Europe is not falling behind and is determined to improve further the performance of transputer-based computers, while making them into more general-purpose machines.

Europe still has something to say in the field of parallel computers. The first stage has already been completed. As part of ESPRIT I, the Supernode project has resulted in commercially available transputer-based machines, which are currently marketed by two companies, the French company Telmat (with T-Node and Meganode) and the British company Parsys, a subsidiary of Thorn-EMI. With this success behind it, Europe is forging ahead. The aim of the PUMA (Parallel Universal Message-Passing Architectures) project, launched in August 1989, is to develop components (including the H1 transputer from Inmos) and architectures for the next generation of massively parallel general-purpose computers. [passage omitted]

PUMA's aim is to improve the communication process between transputers. At this level, there are still efforts to be made. Computer programs are still often linked to a specific transputer network topology, and transferring applications between different machines is consequently not a simple task. One of the solutions is that the software should wait until the hardware itself transmits processor-to-processor messages via "virtual" channels. The hardware must be able to multiplex several of these channels over the physical network without the user needing to specify, for each program, the "path" via which the connection should be made. The programs would have to be totally independent of the transputer network's topology. The PUMA project seeks to achieve this goal in two years time. Worth 15.5 million European currency units [ECU] oday an integral part of SGS-Thomson, and by the UK Royal Signals and Radar Establishment (RSRE). Among the participants are the German company Siemens and the French companies Bull, Syseca, and Chorus Systems. The project is subdivided, broadly speaking, into three parts which concern, respectively: the design and manufacture of components (the C104, a switching integrated circuit, and several communications components of the H1 transputer); the development of technologies to make the maximum use of the H1/C104 tandem and, on a far more theoretical level, research into a parallel processing model called PRAM (Parallel Random Access Machines).

Improving Operating Systems

Inmos is the main company as far as components are concerned. The development of the communications architecture is now complete. It is based, as mentioned above, on virtual channels which allow transmission of messages in the form of packets between tasks which are being carried out by any processor in the network. The H1/C104 combination is expected to reduce point-to-point communication delays by a factor of 10.

Alongside the pure hardware aspect, research is also being carried out into the operating system and the improvement of programming languages (such as Occam). With a general-purpose machine in mind, it would be a mistake not to think of Unix. This is where the company Chorus Systems comes in, once more as part of an ESPRIT project; its Unix-compatible operating system is designed for distributed environments (moreover, Chorus is also working with Intel on Hypercube-type supercomputers, another type of distributed-memory machine). In addition, research is being conducted into the possible dynamic modification (i.e., while a program is running) of task routing among several processors. However, these aspects concern other projects which are under way or on the point of being launched in the ESPRIT program.

PUMA is in fact being developed alongside the Supernode II project, launched in March 1989 under the leadership of Thorn-EMI. Supernode II aims at developing operating systems and programming environments for general-purpose parallel processors on the basis of the results of the first Supernode project. Finally, work begun by PUMA on PRAM, which involves defining a parallel processing model independent of the hardware used, is to continue through the GP-MIMD project (General Purpose Multiple Instructions, Multiple Data Machines), the launch date for which is not yet official. GP-MIMD will take three years and will bring together companies which have already made considerable investments in transputer-based machines such as Telmat, Parsys, Meiko and Parsytec, the overall leader being ... the Inmos manufacturer.

German Gallium Arsenide Technology Reviewed

91AN0189 Paris ELECTRONIQUE HEBDO in French 6 Dec 90 p 19

[Article by Elisabeth Feder: "GaAs Research: Germany Leads the Pack"]

[Excerpts] Is Germany leading by a length in the GaAs race with the other countries of Europe? A cooperative research project with industry, funded for two-thirds by the German Ministry of Research and Technology (BMFT), has in any event produced results that are more than promising.

Should we give up the race for supremacy in the silicon field and secure technological advances in other areas? A pointless question par excellence. And yet, a cooperative project in the field of gallium arsenide (GaAs) involving 20 companies and research institutes in Germany, funded 110 million German marks [DM] by the BMFT and DM60 million by industry, has produced especially promising results. In five years, Wacker-Chemitronic has become a leader on the world GaAs substrate market; Siemens is reported to be today—thanks in part to basic technology developed under this project—the top European supplier of GaAs components; and Telefunken possesses the technology required for the production of

diodes, field-effect transistors (FETs), and analog integrated circuits operating at very high frequencies, up to 2.3 teraherts (THz) for the diodes, for example. From a technological standpoint, the research has resulted in structures with 0.1 micron horizontal line widths and 1.7-nanometer (nm) vertical films (by a method of growth by molecular beam). [passage omitted]

The various projects were coordinated by the Fraunhofer Research Institute. Wacker-Chemitronic is today producing substrates of 2, 3, and 4 inches in diameter of a quality that meets recognized integrated circuit requirements. Its share of the world market rose from 3 percent in 1985 to 15 percent in 1989.

Basic concepts for the manufacturing technology were developed by the Fraunhofer Institute with participation by industry (Siemens and Telefunken) and by other research centers. GaAs-channel high-electron-mobility transistors (HEMTs) and pseudo-amorphous HEMTs (with 25 percent indium), all with 0.25-micron channel lengths as well as an amplifier, comprise the carrier circuits. The transistors exist in several versions and have a typical crossover frequency of between 53 and 200 gigahertz (GHz) maximum. The single stage amplifier has a gain of 9 decibel (dB) at 40 GHz and 3.5 dB at 60 GHz.

A 4-Bit 1.2-GHz Passband AD Converter

The most striking circuits produced by the GaAs project are of several types. A 4-bit analog/digital converter, designed by Fraunhofer and produced by Siemens, integrates 1,000 transistors on a 2.6-millimeter^2 surface. Its outstanding feature is its 1.2-GHz passband, which places it among the finest developments of its type. The most highly integrated component designed under the project is a 8 x 8 2,800-transistor multiplier circuit. It is still under evaluation at the Fraunhofer Institute. A 9,000-transistor 1-Kbit static random-access memory (SRAM) on a 3.6 x 4 mm chip has an access time of 3 nanoseconds (ns).

A laser/modulator circuit—the two components are integrated on a single substrate—was developed at the Daimler Benz research center. Initial measurements tested its operator at 6 GHz, the aim being to attain 10 GHz. A 53-stage ring oscillator has a switching time of 15 picoseconds (ps) for a transistor with a channel length of 0.3 micron and 25 ps for a channel length of 0.5-micron. A switching time of 10 ps is projected if the channel length drops to 0.1 micron.

More concretely, Telefunken has produced Schottky diodes (currently marketed) with a limit frequency of 2.3 THz. A semicustom standard cell library used in the design of complex integrated circuits has also been developed. Siemens is today producing 12-GHz HEMTs and metal-semiconductor field-effect transistors (MESFETs) for satellite reception, as well as microwave monolithic integrated circuits (MMICs) for cellular telephones.

Thomson To Launch Mini-LCDs

91WS0134A Paris LE MONDE in French 21 Dec 90 p 25

[Article by special correspondent in Grenoble Andre Dessot: "Back Projection, Thomson's TV Gamble"; first paragraph is LE MONDE introduction]

[Text] Until large flat screens come onto the market, the French group is going with a cheap and elegant solution.

After 60 years of good and loyal service, will the heavy, cumbersome cathode tube that equips home television sets soon retire? Manufacturers' cherished notion of replacing it with a flat screen hung on the wall like a painting is still a dream, albeit one in which the Japanese already have a hefty lead (14 November LE MONDE). However perfected, though, this home window on the world is nearing the end of its career, and Mr. Hugues Garin, general director of the tubes and display-devices division of Thomson Consumer Electronics (TCE), does not give it more than 10 years. For his part, Mr. Erich Spitz, assistant general director of TCE's "research and technology," is now convinced that the tube will be supplanted by back projection from flat mini-screens. Thomson is consequently putting its money on cinema-screen back projection.

Is this an optimistic view, effectively doing away with any risk of a confrontation between Japan and Europe in the development and marketing of the ideal screen? No one—not even the Japanese, who it is claimed have a two-year technological lead—has any illusions about the technical possibilities of developing before the 21st century a flat screen using the liquid-crystal techniques well-known in watches and calculators. And even when such as screen does exist, moving it from the laboratory to the industrial production stage will raise so many problems that many more years will be needed to solve them.

Thomson LCD (Thomson group) has created a pilot plant in Voreppe-Moirans (Isere) in conjunction with Sextant Avionics. This was done through the European organization Eurodisplay, part of Eureka, and with the participation of the German firm VDO. Since the plant got underway last September, it has begun producing "liquid-crystal flat screens on active transistor matrices." That barbaric phrase simply means that each picture point, or pixel, is equipped with a transistor. And the 6.25-inch screens (22 cm across diagonally) manufactured by Thomson LCD already have over 1 million pixels. At best, Thomson LCD plans to make 9-inch (31 cm) screens between now and 1992. But that is still far from the usual size of tubes equipping home sets. Hence the idea of no longer endlessly enlarging flat screens, whose dimensions are suitable for avionics and even micro-data processing, but reducing them.

Mr. Thierry Robin, general director of Thomson LCD, has officially announced it: In 1992 the company will begin to produce the world's first ever LCD valve tubes

(that is, flat mini-screens the size of a slide), which will be used for back projection. The system already functions in 4/3 format for SECAM [Sequential Color and Memory] and PAL [Phase Alternation Line] with no loss of quality, as is the case with back projection from a cathode mini-tube. This is because the light beam travels through the screen. The equipment may be presented at the Berlin Funkausstellung, the famous German video show, in August of 1991. It is likely that tomorrow, that is around 1995-1996, television sets the size of a CD reader will be incorporated into the components of stereo systems. Then all the user will have to do is house the projector in a piece of furniture and hang a screen on the wall for the show to begin. Though the Japanese firm Sharp has proved the "feasibility" of a 14-inch (49 cm) matrix flat screen, it could well find itself overtaken in high-definition 16/9 back projection. That, at least, is what Thomson is gambling on.

NUCLEAR ENGINEERING

France: Industrial Particle Accelerator Developed

91AN0106 Paris SCIENCES & AVENIR in French Nov 90 p 11

[Text] Designed by Prof Jacques Pottier and developed by a team from the Electronics and Instrumentation Department of the Atomic Energy Commission (CEA), the Rhodotron prototype is the first European particle accelerator for industrial use.

It operates on a classic principle: An alternating electrical field serves to accelerate the electrons while large magnets inflect their paths. Injected into a coaxial cavity with a radial electrical field, the electrons accelerate. When they reach the boundary of the accelerator cavity, the effects of a magnetic field oblige them to make a U-turn. Reinjected into the cavity, they reach a higher speed level, and so on. The process is repeated exactly five times . The recirculation principle makes electrons follow rhodon-shaped, or, for non-Hellenists, rose-shaped paths. The particle beam originating from the accelerator reaches about 3.3 Mev of energy or enough to ionize foodstuffs, for instance.

The Rhodotron meets, in so far as it is possible, the requirements of industry: It takes up a mere 8 square meters of surface area; with certain modifications, it could be turned into a simple push button apparatus; and its recirculation principle makes it economical to use. Its promoters are considering selling it for 6.5 million French francs. Although industry seems increasingly convinced of the efficiency of the ionization process, especially in polymerization of plastic and sterilization of medical and surgical equipment, consumers seem somewhat reluctant to consume "ionization preserved" food.

German Electron Ring HERA Described

91MI0106 Hamburg DESY JOURNAL in English No 3, 1990 pp 3-27

[Article by Volker Soergel (Chairman of DESY's Board of Directors) Introductory paper: "On the Completion of HERA," Peter Schmueser: "The Proton-Electron Storage Ring Facility HERA," Rolf Windels: "The Buildings for HERA"]

[Excerpts] On November 8, 1990 we celebrate at DESY [Foundation of the German Electron Synchroton] the completion of HERA [Hadron-Electron Ring Accelaerator] after a construction time of six and a half years. This edition of the "DESY Journal" is published on this occasion and is devoted exclusively to HERA.

With HERA, the first proton-electron storage ring facility, it will be possible to investigate lepton-nucleon reactions—up to now a domain of fixed target experiments—with colliding beams. The increase in centre-of-mass energy is so large the new scientific grounds will be broken. Interesting new results can be expected concerning the structure of the nucleon and its constituents, the properties of the weak interaction, and the specific features of the strong interaction. But also questions going beyond the established theories will be attacked. The richness of the scientific programme and the unique features of HERA promise interesting years for DESY and all physicists from outside working on the HERA experiments.

The design and construction of the HERA facilities were a great challenge for all people involved. Two storage rings of completely different characteristics have been built, one for electrons, the other one for protons. In designing the components it was often necessary to apply new concepts for technical reasons and to minimize the costs. Examples are the magnet modules, the copper vacuum chambers and the superconducting cavities for the electrons, new magnet power supplies with maximum current stability or the control system. The greatest challenge however, was the design and construction of the superconducting magnets for the proton storage ring including the large and powerful cryogenic system. Here the willingness of the companies involved to venture into new technical territory was essential for the joint effort.

The extensive construction work should also be mentioned. First the 6336 m long tunnel and then the fours underground experiment halls—an interesting problem for the planning engineers and the contractors which was solved excellently.

First of all, we want to thank the DESY staff for their efforts in completing HERA on time. With great enthusiasm physicists, engineers, technicians, members of the workshops and of the administration have accomplished this task which was almost too ambitious for DESY. Everybody has made his own contribution to ensure that

in the coming years research in particle physics at DESY will again be at the forefront.

HERA has been built in international collaboration. Laboratories and research organizations in several countries have developed important components in collaboration with DESY, have had them manufactured by their home industry as their contribution to the HERA project. The most outstanding was the provision of 220 superconducting dipole magnets from Italy. Other countries have sent skilled staff to DESY to join in the HERA construction. They integrated themselves extremely well in the HERA team, and without their help the construction of HERA would not have been possible.

By approving the HERA project and providing the financial resources, the Federal Minister of Science and Technology and the Senat of the Freie und Hansestadt Hamburg have enabled DESY to build a unique research tool. They have also shown their confidence in our ability to master this task. We are also grateful on behalf of the many scientists who now have the possibility to investigate even smaller dimensions of the microcosm at HERA. It is planned to start the research programme at HERA next year with the H1 and ZEUS experiments in which more than 600 physicians from 16 countries are involved. The scientific results are eagerly awaited.

The Proton-Electron Storage Ring Facility HERA

[Passage omitted] A first section of the proton ring was cooled down this summer and was successfully tested with a positron beam. A lot of valuable information was gained in the test which will be used in the commissioning of the whole ring.

HERA is the first storage ring facility ever built in which the most important building blocks of matter—protons and electrons—interact with each other in a head-on collision. The structure of the proton and constituents can be explored with far better resolution than is accessible with conventional accelerators. The two particle beams are guided in separate magnetic rings and collide only in the experimental areas. HERA is thus more complicated than electron-positron colliders like DORIS in Hamburg and LEP at CERN in Geneva or proton-antiproton storage rings like CERN SPS and the Fermilab Tevatron, since in these accelerators the two particle beams circulate in the same magnetic ring. This is not possible for particles of different mass, and, moreover the maximum proton and electron energies in HERA are very different.

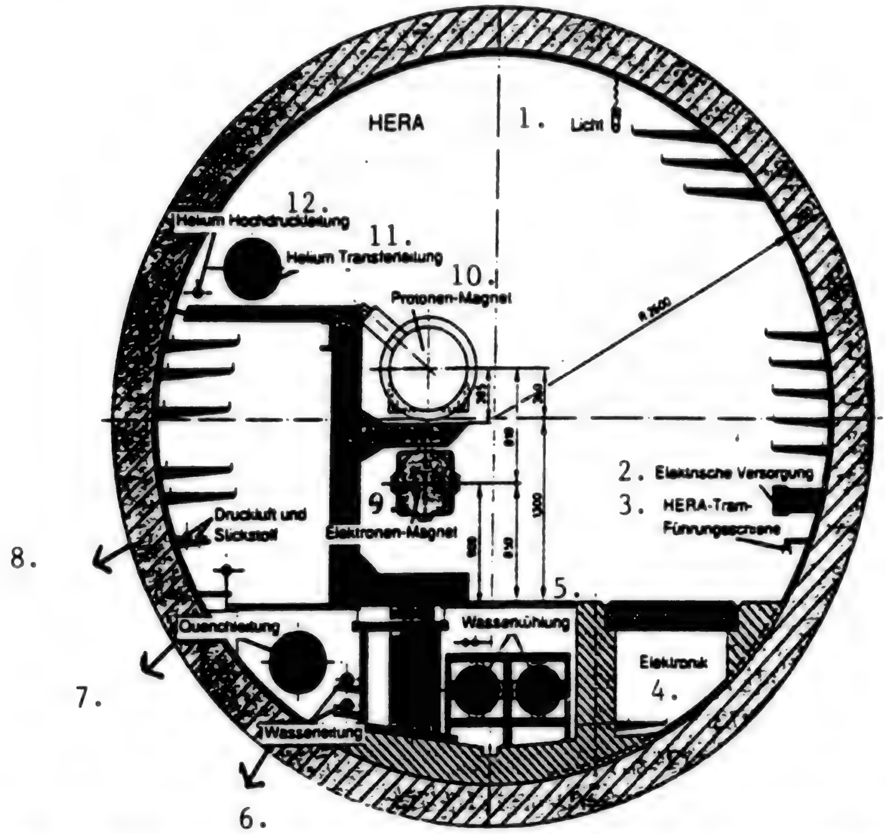
The Influence of Synchrotron Radiation.

The proton energy is only limited by the available magnetic guide fields. Using superconducting magnets the protons can be accelerated to more than 800 GeV (corresponding to a traversed voltage of 800 000 000 000 Volts). The maximum energy of the electrons is much lower and amounts to 30 GeV nominally. Electrons are difficult to accelerate to high energies as they steadily lose energy by synchrotron radiation when passing through bending magnets. The energy losses of the total beam are enormous. To store the electron beam in HERA at 30 GeV, the radio-frequency system of the accelerating cavities has to provide a power of 13 MW (13 megawatts). The power requirements increase with the fourth power of the electron energy so it is impossible to go far beyond 30 GeV. Even increasing the ring would not gain a large factor: in the LEP storage ring with a circumference of 27 km the top electron energy is presently 50 GeV (a second stage is planned with 100 GeV and large RF power). The synchrotron radiation of the protons is many orders of magnitude lower and can be neglected in HERA.

Besides strongly limiting the electron energy the synchrotron radiation and the operation of the HERA collider and of the experiments H1 and ZEUS. To provide head-on collisions without crossing angle, bending magnets are needed before and after the experiments which steer the beams against each other. The synchrotron radiation generated in these magnets has such a high power that it would boil away the liquid helium in superconducting magnets. For this reason, the straight sections are equipped with normal magnets. To reduce the synchrotron radiation background in the detectors to a tolerable level, collimators and careful shielding are needed.

Finally, since the synchrotron radiation extends into the hard X-ray region, it constitutes a significant radiation level in the tunnel. The vacuum chambers of the electron ring are made from 4 mm thick copper and are surrounded by lead to absorb 98 percent of the radiation. Nevertheless, all cables must be equipped with radiation-resistant insulation and semiconductor electronics has to be installed in shielded concrete caves.

From all this it becomes apparent that the synchrotron radiation of the electrons has severe impacts on the HERA storage ring and the experiments. The difficulties are due to the very small value of the electron mass and arise in a similar manner also in the large electron-positron colliders like Tristan at KER near Tokyo and LEP. However, there is also a positive effect: the stored electron beam is in general much less sensitive to perturbations than the proton beam. Since the electrons are steadily losing energy by emitting photons their loss has to be compensated in the accelerating cavities to keep the energy of the beam at a constant value. The combination of radiation and re-acceleration leads to a damping of the transverse and longtitudinal oscillations of the particles, i.e. the amplitudes of these oscillations shrink with time. The electron bunches become narrower and shorter until they reach their minimum dimensions (For experts: this is given by the balance between the damping and the excitation of oscillations caused by quantum fluctuations.) Loosely speaking, this effect is called "radiation damping." It has the additional benefit that oscillations of the electron beam as a whole which have been excited by perturbations in the magnet power supply or other devices are damped out quickly.



One of the arcs of the HERA tunnel where the particles are bent by magnets. The proton ring is mounted on top of the electronic ring

Key: 1. Light—2. Power Supply—3. HERA Safety Rail —4. Electronics—5. Water cooling—6. Water pipes—7. Quench conductivity—8. Pressurized air and nitrogen—9. Electron magnet—10. Proton magnet—11. Helium transfer guide—12. Helium high pressure guide

The proton beam has no radiation damping. The particle bunches are much longer and wider than for the electrons. In addition, the protons "remember" every perturbation. Any oscillation or inadequate regulation of the magnet power supplies is immediately transmitted to the protons and excites oscillations which do not vanish again. If more and more perturbations come in, the beam blows up and may lose much of its intensity. The requirements on the power supplies and the RF system concerning ripple and noise are therefore much more demanding than for electron accelerators. The experience at CERN and Fermilab has shown, however, that with sufficient care proton beams can be safely stored for 20 hours or more.

The HERA Electron Storage Ring

For the HERA electron storage ring many features could be taken over from the former electron-positron collider PETRA, which is now used as a pre-accelerator for HERA, but there are a number of remarkable novelties. The ring is composed of preassembled modules, each containing a nine meter long dipole, a quadrupole and a sextupole. The installation and alignment in the tunnel was greatly simplified. The coil of the dipoles consists of a single aluminium conductor of large cross section which is insulated by a prefabricated glass-fibre-epoxy box. This design, being very cost-effective, has the big advantage that the insulation is insensitive to radiation load. Considering the damage in the PETRA magnets which requires re-insulation of all coils, this is a big improvement. A new technical development is also the use of copper vacuum chambers mentioned above.

The electron ring is equipped with 82 normal-conducting 500 MHz cavities which were taken over from PETRA. To reach the design energy of 30 GeV additional superconducting cavities are needed (see Box 1). These have been produced by industry and are presently being tested. The first commissioning of the electron ring took place in August 1988 and was immediately successful. In the summer of 1989 the beam was accelerated to 27 GeV and stored for many hours. To reach the design electron currents in PETRA and HERA feedback systems are needed (see Box 2).

The HERA Proton Storage Ring

When HERA was planned no large superconducting accelerator existed and the magnets for the Tevatron,

then under construction at Fermilab, suffered from a variety of problems. Meanwhile, the Tevatron has been upgraded to a proton-antiproton collider featuring excellent luminosity at the highest energy presently available. The pioneering spirit of our American friends has paid off. Part of this spirit can also be found in the HERA project with its large scale application of superconductivity in the magnets of the proton ring and in the cavities of the electron ring as well as in the scientifically and technically demanding goal to collide particles so different, as electrons and protons.

In the superconducting magnet prototype program we have tried to profit as much as possible from the experience of the Americans to avoid unnecessary delays or wild goose chases. The first 6 m long dipoles were basically copies of the Tevatron magnets. Their good performance was the precondition for the approval of the HERA project. On April 6, 1984 the Federal Minister of Research and Technology Dr. Heinz Riesenhuber and the then Hamburg Senator for Science and Research Prof. Hansjorg Sinn signed the document of approval in front of one of these magnets.

In January of the same year a significant change of the magnet concept was proposed allowing reduction of the coil current by 600 A and improving the operational safety of the HERA accelerator. It was suggested mounting the iron yoke not outside the cryostat as before but have it directly surround the collared coil and installed inside the liquid helium container. The advantages of the new concept, first derived from calculations and shortly afterwards from 1 m long model magnets, turned out to be so convincing that it was decided to equip HERA with the new type of magnet in spite of an unavoidable time delay. At the same time the length of the dipoles was increased from 6 m to 9 m thereby reducing the number of dipoles from 624 to 416 with corresponding savings in the costly cryostat ends.

With the HERA project for the first time large series of superconducting magnets have been produced in various industrial firms (see Box 3). The magnets have met all expectations concerning field quality and electrical safety. The rejection rate was only about 1 percent, far below the expected level. The approved or proposed projects Superconducting Super Collider SSC in Texas, USA, Large Hadron Collider LHC at CERN and UNK in the Soviet Union will all use magnets of the "HERA type."

Superconducting magnets generate significantly higher field than normal magnets and do this at much reduced operational costs. The HERA dipoles have a nominal field of 4.7 T (Tesla), far beyond the saturation magnetization of iron. Some 6MW are needed in the helium refrigerator to cool the HERA ring with a stored beam at 800 GeV compared to the 52 MW required to power the normal magnets of the CERN SPS at a proton energy of only 315 GeV.

Superconducting magnets have a number of properties which are not found in normal magnets and require careful attention. It is no longer possible to determine the field pattern with accurately shaped iron pole shoes but the coils must be fabricated with extreme precision in order to keep the field errors within the tolerable limits of about 0.01 percent. The conductors in the coil have to be positioned with an accuracy of typically 0.02 mm. This precision must be maintained in the presence of huge magnetic forces: at 5 T, the two halves of a HERA dipole coil repel each other with a force of one million Newton per meter length (this corresponds to the weight of a heavy truck). Very strong clamps ("collars"), surrounding the coil, take up this force and guarantee the mechanical precision. The experiences at Fermilab and DESY have shown that this concept works well and yields magnets with excellent field quality up to their highest field.

An unpleasant property of a superconductor is the "quench," the sudden and undesired transition to the normal state. If that happens the high current in the coil must be reduced to zero in less than a second to avoid overheating and destruction of the coil. Quench recognition and protection are among the most important tasks at a superconducting accelerator. At DESY a lot of research and development has gone into this area. Quenches may be triggered by local overheating of the cable beyond its critical temperature, for example when the conductors move slightly during the excitation of the magnet. By choosing a high precompression of the coil these quench origins can be largely eliminated. The HERA magnets have all passed the nominal field of 4.7 T and most of them could even be excited to the critical current of the superconductor (corresponding to more than 6 T) without a premature quench. In spite of this ample safety margin quenches might still occur if a large fraction of the proton beam hits the coils or if the helium cooling breaks down. An elaborate safety system is therefore indispensable.

The advantage of superconducting coils turns into a drawback at low excitation. The eddy currents, which are induced in any coil when the field is changed, do not decay exponentially but continue to flow forever. These bipolar "persistent" currents generate field distortions which are far beyond the tolerable level at the low proton injection energy of 40 GeV and require and elaborate system of superconducting correction coils. The field distortions exhibit a pronounced hysteresis (see Figure 1) and in addition a small time drift (Figure 2) which also has to be corrected for. The control and programming of a superconducting accelerator is evidently more complicated than that of a normal one but presents no basic difficulties as proven by the successful operation of the Tevatron. To facilitate the control of HERA we have carefully measured and calculated the persistent current effects in all magnets will be installed in which the field distortions can be measured during the injection and acceleration phase of the proton beam.

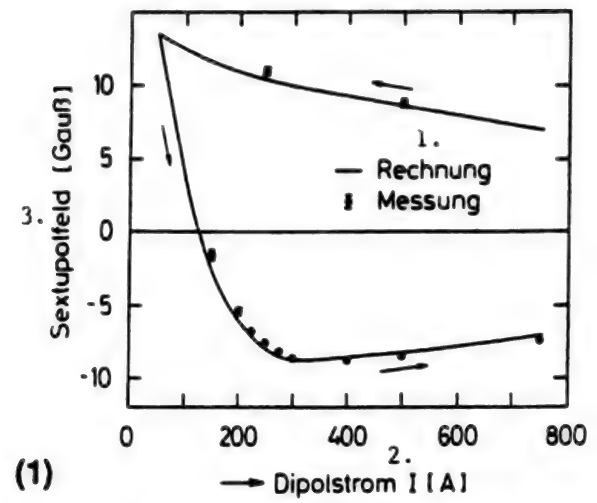


Figure 1. The sextupole field in a superconducting dipole magnet for increasing and decreasing current. The lower curve is used for the injection of the protons at 246 A.

Key: 1. Calculation Measurement—2. Dipole Flow I [A]—3. Sextupole Field [Gauss]

Installation of the Proton Ring and Test of the First Octant

The installation of the superconducting magnets in the tunnel started about a year ago and was finished in October this year. The installation comprises many carefully scheduled tasks: transportation and mounting of the magnets; alignment; connection of beam pipes and leak search; soldering of the superconducting cables for the main current and the correction coil currents; check of the electric connections; welding of the tubes for liquid, two-phase and gaseous helium; mounting of radiation shields and superinsulation; connection of cryostat vacua; pumping and leak search. Most of the superconducting correction coils are mounted on the beam pipes inside the dipole or quadrupole magnets. Since their field cannot be measured from the outside much effort has gone into checking the electrical connections. The circuit diagrams were generated by computer and a computer-controlled measuring system was used to ensure that the correction coils are all connected to their appropriate current supply and have the correct polarity. There are over 1000 of them, so this was not a trivial task.

The first section of the HERA-ring, the octant "West Left" extending from Hall West towards the centre of the arc in south direction and comprising 52 superconducting dipoles and 26 quadrupoles was cooled to its operating temperature of 4.5 K (4.5 Kelvin = -268,7°C) in March 1990. Gaseous helium was pumped through the magnets whose temperature was gradually lowered from 293 K (room temperature) to 80 K (liquid nitrogen

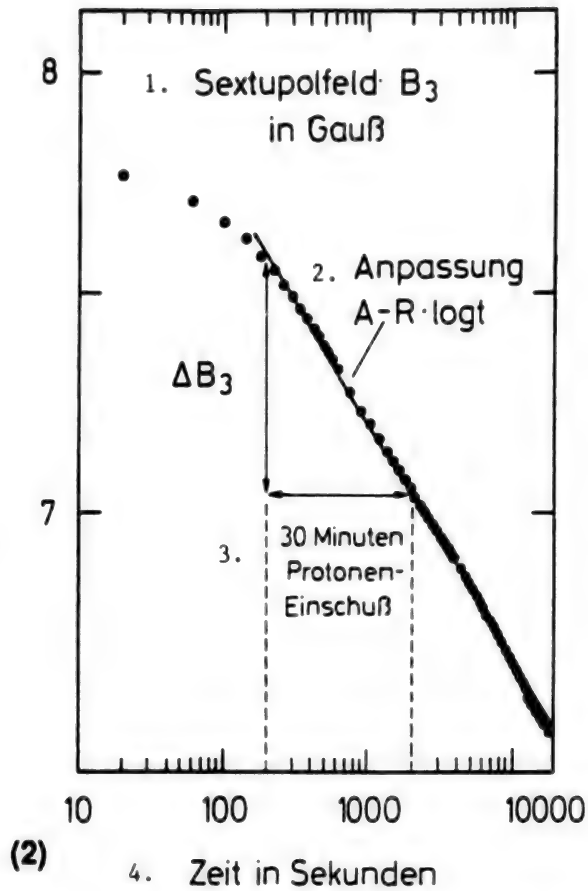
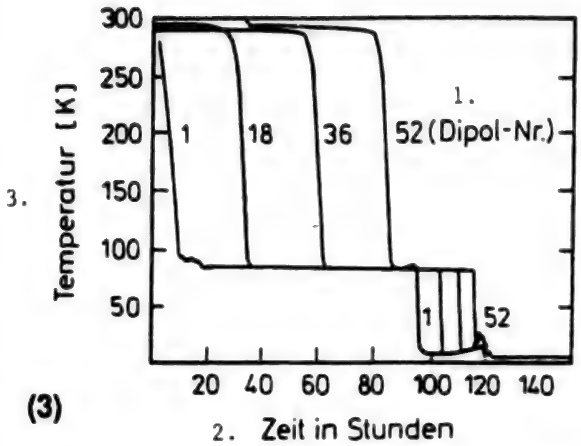


Figure 2. The change of the sextupole field of a dipole magnet during the 30 minute proton injection period.

Key: 1. Sextupole field B^3 in Gauss—2. Approximation to A-R logarithm— 3. 30 minute proton injection—4. Time in seconds

temperature). The cooling power was purposely reduced to avoid temperature gradients of more than 50 degrees in any magnet. (With full cooling power one could achieve temperature differences of more than 200 degrees between beginning and end of a magnet. The resulting mechanical stresses would be excessive and could lead to permanent deformations and other damage). Figure 3 shows the time variation of the temperature in several magnets of the octant. The 80 K level was reached after 90 hours. The cooldown was continued with colder gas and finally with liquid helium. It took only 30 more hours to reach 4.5 K since the heat capacities of coil and yoke become very small at low temperatures. In the cold octant the amount of energy which flows via heat conduction and radiation into the liquid helium container and to the radiation shield was measured. The measured values conform with the expectations, so only two of the three cryogenic plants are needed to cool the whole HERA ring.



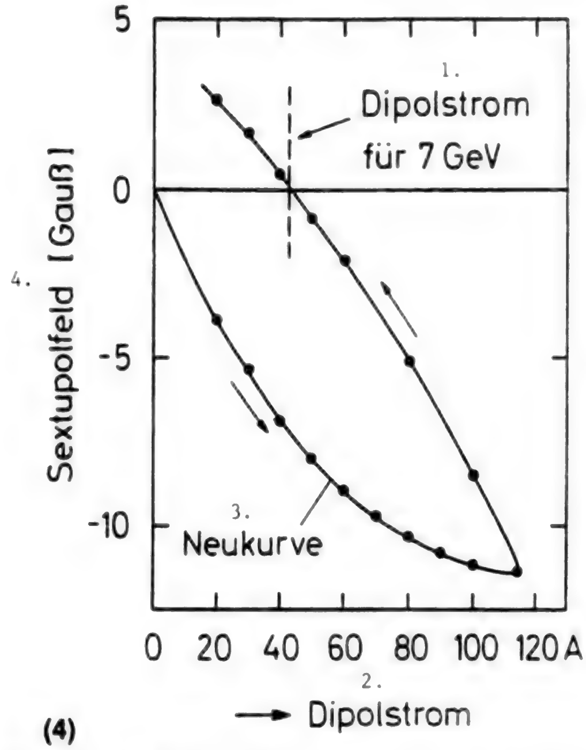
(3)

Figure 3. The cooling procedure of the first HERA octant consisting of 52 superconducting dipoles and 26 superconducting quadrupoles. The diagram show the temperature profile in four dipoles.

Key: 1. Dipole Number—2. Time in hours—3. Temperature

In the next step the quench protection system was checked. By means of the built-in electric heaters the magnets were quenched one by one at an operating current of 1000 A. It was verified that the quench detection system worked properly in every single case and caused the coil current to be switched off. initially, there were some false alarms from cross talk but it was possible to eliminate them by adjusting the detection thresholds. The second important goal of the octant test has thus been accomplished: to check and verify the reliability of the quench protection system.

During the end of June and beginning of July a particle beam was passed through the octant. Since protons of 40 GeV were not available the experiment was carried out with positrons of only 7 GeV. The field distortions from persistent currents are normally hundredfold larger than tolerable at this extremely low energy and compensation with the correction coils appeared difficult. For this reason the magnets were subjected to a special initialization procedure which following theoretical considerations—had been first tried out on two magnets: The whole octant was warmed up to 20 K to make all magnets normal conducting and extinguish any persistent currents left over from the previous current cycles. The coil current was raised to 112 A and then reduced to 42.5 A, the value needed for the 7 GeV positron injection. Figure 4 shows that the sextupole field rises to 13 Gauss at 112 A but decreases when the current is ramped down and crosses zero just at 42.5 A. (For experts: the previous warm up ensures that no magnet flux remains trapped in the superconductor. The superconductor is then first in the Meissner phase and, with increasing coil current, enters partly the mixed phase. By a proper



(4)

Figure 4. The diagram shows a special running-in procedure of the superconducting proton magnets during the first octant test, before 7 GeV positrons were injected into this 700 m long section. The disturbing sextupole field vanished if the upper curve is used

Key: 1. Dipole flow for 7 GeV—2. Dipole Flow—3. New Curve—4. Sextupole field [Gauss]

choice of the maximum current (here 112 A) the hysteresis curve can be matched to the requirements as shown in Figure 4. A corresponding adjustment would however, not be useful for the proton injection at 40 GeV: in the subsequent acceleration phase the field distortions would rise rapidly and become as large as shown in Figure 1.)

It took only 15 minutes to steer the positron beam through the octant although only two monitor screens were available at this moment. The 26 positron monitors were successfully operated a few days later. The optics of the octant was checked by means of oscillations of the whole beam excited by correction dipoles as well as the correct functioning and polarity of the correction quadrupole and sextupole circuits. So the positron test of the first HERA octant has been very successful and gives a lot of encouragement for the commissioning of HERA. It is planned also to check the whole ring initially with positrons since particle pulses are available every second which is very helpful in adjusting the electronics of the position monitors. Finally, the magnet current was raised in steps to the nominal value of 5000 A. Even 6000 A were achieved for a while without quenching a

magnet. This demonstrated that a whole octant can be operated at the nominal current and well beyond.

The Pre-Accelerators for HERA

Like all large accelerators, the HERA rings also need a whole chain of pre-accelerators, which are all operated from the main control room. This is well known at DESY for the electrons. For the protons one starts with negatively charged hydrogen ions, i.e. proton with two attached electrons. Their production in an 18 keV ion source and the two first pre-accelerator steps radio frequency quadrupole and linear accelerator) are described in Box 5.

The advantage of H-ions is that they can be easily injected into DESY III. Inside the injection magnet there is a very thin foil (200 μm) which strips off the electrons and transforms the negatively charged ions to positively charged protons. By means of this trick it is possible to add more particles to the already circulating proton bunches in DESY III. (For experts: the Liouville theorem is thereby circumvented and one can increase the particle density in phase space.) PETRA has to accelerate the protons from 7.5 to 40 GeV but the studies have not yet been finished.

Outlook to the Near Future

The north half ring was cooled down in October, the south half ring will follow in December. The first circulating beam is expected in the spring of 1991. For the proper operation of the proton ring a number of control and steering programs still have to be written and the reference magnets have to be commissioned. Considering the large progress made 1990 these tasks can be attacked with confidence and determination. The first proton-electron collisions in HERA are expected in summer 1991.

The Buildings for HERA

When the DESY physicists presented their ideas on the construction of the HERA storage ring and looked for a possible site the unanimous response of the civil engineers was that there was no chance to build such an enormous tunnel with a circumference more than 6 km, in Hamburg, and even less so close to the DESY site.

Nevertheless, it worked out well. After much searching and with a lot of luck three suitable sites for the experimental halls were found outside the DESY site. Application was submitted for the rights to tunnel under land which did not belong to DESY and the Hamburg planning office quickly approved it.

The tunnel runs with a radius of about 2 km in an almost circular path under the neighbouring Altona Volkspark. To the west and south it lies under industrial and urban land, but otherwise under parkland and open country. The depth of the tunnel is matched to the landscape. It lies in an inclined plane which has its highest point in the south and slopes down to the north at 1 percent. This means that the largest height difference is 20 m. The axis of the tunnel is at a depth of up to 30 m.

The subsoil consists largely of layers of sand whose uniformity is disturbed at isolated points by glacial marl. This subsoil was laid down in the last ice age and is therefore scattered with boulders of various sizes. In the south the tunnel is above the water table, but in the north lies up to 15 m below it.

The experimental halls are up to 27 m deep and are constructed of reinforced concrete. A hall has a floor area of 43 m by 25 m and is 15 m high. Only small access buildings are visible at the surface and heavy components are lowered by crane.

The tunnel was built according to mining techniques by means of a hydraulically driven shield. This type of machine is particularly suitable for the light subsoils of northern Germany. The walls are lined with reinforced concrete segments 30 cm thick, and the tunnel has an inner diameter of 5.2 m.

Construction was commenced in May 1984, immediately after approval by the Federal minister of Research and Technology and the Senator of Science and Research of the Freie und Hansestadt Hamburg was received. One year later tunnelling began from the first experimental hall and the circle was completed in August 1987. The basic construction was completed in January 1988.

The constructional costs stayed just below DM 230 million excluding value added tax, and were exactly within the estimate. Civil Engineering, Structural Design, Specification, and Construction Supervision: Dr. -Ing. Rolf Windels, Dr. -Ing. Guenter Timm, Dr. -Ing. Karl Morgen, Consulting Engineers VBI.

[Box insert 1, p 8]

Dieter Proch: "Superconducting Cavities for the Electron Ring"

The acceleration units of the HERA electron ring are cavity resonators with an eigenfrequency of 500 MHz (500 000 000 oscillations per second). At present the ring is equipped with 82 normal conducting cavities which provide a circumferential voltage of 145 MV (145 000 000 Volts). In addition, 16 superconducting cavities will be installed raising the voltage to 241 MV.

The field strength of a copper cavity is limited to about 1 MV/m because of the heating of the metal. Superconducting niobium cavities have been developed at DESY for HERA and at CERN for LEP. They allow field strengths up to 8 MV/m and are limited by field emission effects. The maximum power which can be transferred to the beam is at present 100 kW per resonator.

In contrast to the loss-free flow of a direct current in superconducting magnets the high frequency currents in cavities lead to]losses due to eddy currents even in ideal superconductors. The generated heat has to be extracted by liquid helium. A total electric power of 400 kW is

needed in the helium refrigerator to provide the cooling for 16 resonators. This, however, is only 10 percent of the power consumption of normal cavities with equal performance.

The electrons in the storage ring are concentrated in 210 bunches of 2 cm length each. The circulating beam current contains a dc part and high frequency components. When the electron bunches pass through the cavities they are not only accelerated but also can excite oscillations in the cavities. These "higher mode" oscillations lead to losses and have a negative influence on the beam. Therefore one of the main tasks was to design an antenna (see photograph) which damps the unwanted oscillations but leaves the accelerating field undisturbed.

In a prototype programme important single components of the resonators and cryostats have been developed at DESY. Based on the experience with these prototypes, 16 resonators and their cryostats have been built in industry. After testing they will shortly be installed in HERA.

[Box insert 2, p 10]

Dieter Kohaupt: "Feedback System for PETRA and HERA"

In electron storage rings the energy lost via the emission of synchrotron radiation is compensated in the acceleration cavities. Unfortunately, the bunches themselves excite electromagnetic fields (so-called parasitic fields) in the cavities leading to forces between different bunches. These forces increase with increasing beam current. Above a certain threshold the bunch motion becomes unstable and it is impossible to achieve higher intensities.

The way out is the following: By means of a pickup electrode any deviation of a bunch from its "equilibrium orbit" is recorded. From the signal a current pulse is generated which feeds a correction coil. Thereby the original orbit is restored. Such a feedback system requires a considerable technical effort and has been successfully tested at PETRA recently.

In principle it functions as follows: A pickup electrode generates a signal which is proportional to the (generally very small) deviation of a bunch from the design orbit. The signals are very weak and a high gain is needed in a low noise amplifier. This detector amplifier as well as the associated digital and analog electronics have to be very fast to be able to distinguish between adjacent bunches which are only 96 ns (0.000 000 096 seconds) apart in PETRA and HERA. The amplified signal is digitized and filtered. The correction signal is derived by digital methods and then converted back to an analog signal. This signal steers a fast power amplifier which sends a current pulse to a correction coil correcting the orbit deviation.

The requirements concerning speed and precision of the system are very demanding for the physicists, engineers and technicians involved in the design and construction. For example, the signals have to be transferred with an accuracy of better than 2 ns.

Since the particle bunches can become unstable in the horizontal, vertical and longitudinal (beam) direction, feedback systems for all three directions have to be installed. This has already been accomplished for PETRA and the systems have been successfully tested. It was possible to raise the beam current from 2.5 mA to 45 mA. For the HERA ring these systems are under construction.

[Box insert 3, p 12]

The Realization of the HERA Project—An International Undertaking

The proton-electron collider HERA was realized in international collaboration with contributions from laboratories and research centers from six countries. These contributions came in the form of components for the HERA storage rings and injection systems, developed and constructed by the participating institutes in cooperation with local industry. In addition, skilled staff from five countries were sent to DESY for one to three years to join in the HERA construction during the whole six and a half years. This shows the great interest of the science community in HERA.

The contributions in detail are:

CEN [Nuclear Engineering Research Center], Saclay, **France**

Design of the superconducting quadrupole magnets for the proton ring, development of the production tooling and construction of prototypes in collaboration with DESY, technical responsibility for the whole series production of 246 quadrupole and as a French contribution provision of 126 quadrupoles produced by French industry.

Weismann Institute of Science, Rehovot, **Israel**

Design, construction and test of the main current leads which connect the 4.5 K coil and the room temperature current leads for the superconducting magnets.

INFN [National Institute of Nuclear Physics], Rome, **Italy**

Delivery of 232 superconducting nine metre long dipole magnets, manufactured completely by Italian Industry—this amounts to half of the total number of superconducting dipoles needed for the proton storage ring.

TRIUMF Laboratory, Vancouver, **Canada**

Design and construction of the 80 m long beam transport system to take the 50 MeV negative hydrogen ions from the linear accelerator "LINAC III" to the proton synchroton "DESY III."

Chalk River Nuclear Laboratory AECL, Chalk River

Design, construction and test of the 52 MHz radio-frequency systems for the proton acceleration in "PETRA II" and for the first bunch compression in HERA

National Institute for High Energy Physics NIKHEF, Amsterdam, **Netherlands**

Development of superconducting correction elements for the proton machine in co-operation with DESY and Dutch industry, provision of about 450 correction quadrupole and sextupole coils and 250 correction dipoles manufactured by Dutch industry.

Brookhaven National Laboratory BNL, Upton, **United States**

Quality control of the superconducting cable for the dipole and quadrupole magnet coils and the correction elements.

P.R. China, Poland, CSFR, former GDR, United Kingdom

Physicists, engineers and technicians from five countries were sent to DESY to collaborate in the HERA construction, (their stays in Hamburg was normally between one and three). About 50 people from P.R. China, 40 from Poland, three from Czechoslovakia, three from the former GDR, and three from the United Kingdom worked at DESY at the same time.

[Box insert 4, p 18]

Gerhard Horlitz: "The Refrigeration System for HERA"

The central refrigeration system of HERA has to cool down all superconducting components of the HERA storage rings and of the two experiments to 4.5K (-268.7°C) and has to maintains the temperature at this level with a circulating proton beam.

The following cooling power is required: 13.6 kW (13 600 watts) at 4.5 Kelvin, 40 kW at 40 K and 42 g liquid helium per second for the cooling of the current leads. This power is subdivided between two identical plants, each supplying one half ring of HERA. The primary electrical power is 2.7 MW per plant. For redundancy a third refrigerator has been added. The liquid helium and the cooling gas is distributed around the ring by two vacuum insulated transfer lines, each 3.5 km long.

The refrigeration is provided by means of a closed helium circuit: room temperature helium gas at a maximum pressure of 18 bar passes through a system of heat exchangers and turbines. Generating mechanical work in the turbines, the helium is cooled down to a temperature of 5 K at a pressure of 3.5 bar. The operating temperature of 4.5 K is established in the distribution boxes in the tunnel making use of the so-called Joule-Thomson Effect.

Compressors, coldboxes and all auxiliary equipment (gas purifiers etc.) are concentrated in a central cryogenic hall. The 52 dipoles, 26 quadrupoles and the correction coils of one HERA octant are cryogenically connected in series with one common helium flow. In the event of a quench the helium evaporating from the magnets is guided through safety valves into a collecting line which is installed around the whole tunnel and is connected to the storage tanks in order to recover the gas.

The central refrigeration plant has been in operation continuously during the past three years to supply the test benches on which all HERA magnets were extensively tested before their installation in the tunnel. In this period and during the cooldown and test of the first 700 m long HERA octant the refrigeration system and all control circuits worked very reliably.

[Box insert 5, p 20]

Uwe Timm: "The First Pre-Accelerator Stage for HERA's Protons

The protons reach the HERA injection energy of 40 GeV in three steps via the pre-accelerators "LINAC III", "DESY III" and "PETRA II." In the first stage they are accelerated together with two electrons attached to them, i.e. as negatively charged hydrogen ions. These are particularly suitable for the injection into DESY III. They are produced in an ion source in which hydrogen gas is decomposed by a hot plasma into atoms, protons and electrons. When cesium is present negative hydrogen ions are formed which are removed from the discharge chamber by a positive voltage of 18 keV (18 000 Volts).

A novel accelerator of only 1.2m length, a radio frequency quadrupole (RFG), raises the ion energy from 18 to 750 keV. The principle was proposed in 1969 by the Russian scientists Kapchinskij and Teplyakov but this device could only be built in the beginning of the eighties with computer-controlled milling machines which achieve accuracies in the μm (0.001 mm) range. The device has four electrodes with a sinusoidal modulation along the axis. An electric field of 200 MHz (200 000 000 cycles per second) influences the beam in three ways: the ions are collected into bunches synchronized with the r.f. wave, they are focused towards the axis and they are accelerated to 750 ke V. The RFQ is much more compact and less expensive than the previous electrostatic accelerators which needed dc voltages of 1 MV and large buildings.

The 750 keV ions have 4 percent of the speed of light and need further acceleration before they can be injected into the synchrotron DESY III. The linea accelerator "LINAC III" consists of three Alvarez-type resonators of 1 m diameter and with a total length of 34 m. The acceleration is provided by 131 drift tubes of increasing length to match the increasing velocity of the ions. The energy is transferred to the ions by an electric field oscillating between the tubes which has a power of 5000 kW. The beam passes the three resonators in less than a

microsecond and has then gained a kinetic energy of 50 MeV, sufficient for the injection into DESY III.

SUPERCONDUCTIVITY

France: CNET Develops Thick-Film Superconductor

91AN0204 Paris ELECTRONIQUE INTERNATIONAL HEBDO in French 10 Jan 91 p 6

[Text] The National Center for Telecommunications Studies (CNET) has patented a process to produce superconducting thick films that is likely to break through the current limits of conventional hybrid circuits by reducing dissipation. This process allows the use of conventional thick-film technologies and equipment to create superconducting connections in hybrid circuits and various passive components. These connections remain superconductive to up to 104 Kelvin and have a current density transmission rate of 100 A/cm^2. The latter characteristic ensures compatibility with existing processes and constitutes a significant step toward initial applications.

TELECOMMUNICATIONS R&D

EC Upgrades Data Communications Networks

91AN0195 Amsterdam COMPUTABLE in Dutch 4 Jan 91 p 2

[Article by Nigel Tutt: "EC Appropriates 1 Billion Guilders to Network Research; Negotiations on ESPRIT and RACE Sluggish"]

[Text] Brussels—The research ministers of the EC member states have decided to appropriate 376 million European currency units [ECU] (almost 1 billion guilders) to the improvement and interconnection of data communications networks within the European Community. However, talks on the subsequent phases of the European Strategic Program for Research in Information Technologies (ESPRIT) and the Research in Advanced Communication Technologies in Europe (RACE) program seem to be progressing less smoothly.

The ministers have also reached an agreement about the distribution of funding among the different subfields. Thus, funding will primarily be allocated to data communications projects in the fields of transportation and environment, and to a lesser extent to projects involving customs, social security, or central government applications. So far, ECU124 million have been allocated to transportation and environment, and ECU54.5 million to health care applications.

Of the overall ECU376 million budget, only a little over ECU41.3 million has been appropriated to government-related data communications projects, and another ECU22.5 million to library applications. Under pressure from Italy, ECU14 million was allocated to networks intended for rural areas.

Research projects in these fields will receive financial support for a period of four years. In addition to the funding granted by Brussels, the projects are also financed by the institutes and companies which are actually running them. Most projects will focus on the testing of new technologies, on pilot projects, and on the adaptation of services to customer requirements.

The talks on the subsequent phases of the ESPRIT and RACE programs are progressing rather sluggishly. Officials in Brussels reported that several governments are pressing for stricter selection criteria regarding the admission of organizations from non-EC countries to ESPRIT or RACE projects. They insist on the implementation of the principle of reciprocity.

They are also calling upon the EC Commission to play a more important role in a big EC project which aims at improving the productivity of software development. This project is scheduled to run in parallel with the Joint European Submicron Silicon Initiative (JESSI).

Europe-Wide Mobile Telephone System Under Way

91AN0222 Maidenhead TELEFACTS in English Dec 90 pp 5-6

[Article by Rohan Kariyawasam of Datapro Research: "Europe: GSM Scorecard"]

[Text] In September 1987, seventeen countries signed a Memorandum of Understanding (MOU) to introduce a new pan-European digital cellular mobile radio communications service in 1991. A working party under the auspices of the European Conference of Posts and Telecommunications (CEPT) was set up to define this service.

The working party, called the "Groupe Speciale Mobile" (GSM), is now a Technical Committee responsible to the European Telecommunications Standards Institute (ETSI). Although the GSM specification has come a long way since 1987, the target date of July 1991 for GSM commercial service is now widely recognized as having slipped by some six months.

GSM is one of the most complex cooperative projects ever to be undertaken within Europe. The GSM working party has had to advance the frontiers of radio technology and reach agreement on interfaces and complex cost tariffs.

Despite these technical and political problems, GSM is now on the brink of commercial launch. From a strategic

viewpoint, GSM and its related technologies have provided Europe with a telecommunications vision: that of international roaming and mobile access to a powerful range of integrated services digital network (ISDN) services.

Most European countries have plans to introduce GSM systems within the next two years. The breakdown by country is as follows.

Belgium

A Siemens/Philips consortium has been awarded contracts to build the initial phases of the Belgium GSM network. These initial phases are due to support 24,000 subscribers, and are planned to be operational by the end of 1991.

Denmark

Telecom Denmark will act as a coordinator of GSM service between the four regional Danish telephone operating companies: Copenhagen Telephone (KTAS), Jutland Telephone (JTAS), Funen Telephone (FT), and South Jutland Telephone (TS), Telecom Denmark has also encouraged competition by removing its objection to a second GSM operator. Although license applications for the second GSM network have not yet been called for, the first network is to be based on Ericsson equipment, and is expected to be operational in Copenhagen by 1991.

France

France Telecom plans to open a GSM network in Paris by 1991/1992. Two consortia, the ECR 900 group and Matra Ericsson Telecom (MET), have each been awarded a contract for pilot schemes with a capacity of 10,000 subscribers per scheme. The French PTT does not however, have a monopoly of the French marketplace. The French Mobile Telephone Company (SFR) plans to run a competitive GSM network, although the license has yet to be approved.

Germany

West Germany has planned two GSM networks for 1991: D1-Netz operated by Deutsche Bundespost Telekom, and D2-Netz, operated by a consortium headed by Mannesmann AG. The various players involved with D1 include Philips, ANT, Bosch/Telenorma, and Siemens. A combination of Alcatel's System 12 and Siemens EWSD public switches are expected to be used.

Ericsson and a consortium including Siemens, Philips, and Bosch have successfully competed for contracts for the D2-Netz network. Valid for 15 years, the D2 license states that 75 percent of the preunification FRG must be covered by 1994. D1 is expected to do the same with its consortium's D2 network.

Greece

Following the cancellation of an agreement between the Hellenic Telecommunications Organization of Greece and Racal Telecom for the first mobile TACS communications network in Athens, the Greek authorities sought the advice of the European Commission (EC). The authorities wanted help in evaluating whether an analog cellular network or a GSM system should be the first mobile network installed in Greece.

In May, after commissioning a study from external consultancy, the EC recommended that Greece should move directly to a GSM system. Although Greece is entitled to assistance funds from the Special Telecommunications Action for Regional Development (STAR) program, the Greek authorities have yet to make a decision regarding GSM.

Ireland

Telecom Ireland has recently announced plans to open a GSM network in 1993.

Italy

Confusion exists as to the number of GSM systems scheduled for operation in Italy. The Italian Telecommunications Operations Company (SIP) has confirmed its plans for a GSM network by 1992/1993, with a preoperational trial system to be supplied by Telettra (now part of Alcatel). Two other consortia, one consisting of Racal Telecom, Fiat, and Fininvest, and the other of Olivetti, Televerket, Bell Atlantic International, Cellular Communications Inc., and Shearson Lehman Hutton, have indicated a strong desire to operate a GSM network in Italy. SIP, however, seems reluctant to introduce competition.

Luxembourg

The Luxembourg Telecommunications Authority has confirmed plans for a GSM network by the end of 1991. The authority plans to offer nationwide coverage from the start.

Netherlands

The initial phase of the Dutch GSM is scheduled to begin in 1992, with nationwide coverage planned for 1995. Alcatel BV, Nokia, and AEG have formed a consortium that will be the supplier for the infrastructure.

Portugal

Two competing GSM networks are to be offered in Portugal. The TP/TLP network is scheduled to start by the end of 1991, and an independent network operated by a consortium is likely to include Portuguese and non-Portuguese organizations.

Spain

In Spain, two preoperational GSM systems have been commissioned by Telefonica. Telcel will build a system

in Seville, while Intelsa (an Ericsson subsidiary) and Telettra, of Italy, will install a system in Barcelona. Both are to be operational by the end of 1991. Following this, the first phase of the commercial Spanish GSM system will be opened in Madrid in 1992.

United Kingdom

GSM networks are planned to be opened in the UK by 1991. At present, Cellnet and Racal are the major players, and both will be supplied by the same switch manufacturers.

France: High-Speed Open Network Developed

91AN0197 Le Chesnay INRIA INFORMATION in French Dec 90 p 2

[Article: "RODEO Project: High-Speed Networks, Open Networks"]

[Text] The project's purpose is to define and test protocols which will allow to make the best possible use of the future 1-Gbit/s and more powerful networks. The project implies:

— Research on protocols for high-speed transmission control, their parameterization, and their integration in operating systems;

— Research on management functions ensuring applications synchronization and the transparency of data between heterogeneous machines.

These activities involve the development of high-speed applications (messaging, multimedia conferences). They often give rise to industrial cooperation, especially within the framework of the ESPRIT THORN projects and the subsequent OSI-95 project, and they take into account the latest standardization developments.

The purpose of the ESPRIT THORN project was to develop software for a distributed directory based on the X.500 standards. This project has now come to an end; the RODEO team designed and subsequently implemented the communication layers.

The results obtained during or as a result of this project include:

— The development of a distributed directory based on the X.500 standards, called "PIZARRO";

— The development of a compiler for the ASN.1 data representation language, called "MAVROS";

The purpose of the ESPRIT OSI-95 project is to define the protocols for networks operating at very high speeds; it was launched in November 1990. The National Institute for Research on Information Science and Automation (INRIA) was invited to participate in the project on account of two previous achievements:

— The definition of a transport protocol (TP-5), suitable for controlling data flows generated by multimedia applications;

— The definition of a data representation protocol called "FTLWS," which can substitute the basic transfer rules defined in the ASN.1 language, and which leads to a substantial coding rate gain.

It should be observed that the FTLWS protocol has been proposed for standardization by ANSI.

Deutsche Bundespost Telekom Initiates Pilot Videotext Program

91WS0108A Leinfelden-Echterdingen EEE in German 13 Nov 90 pp 4-8

[Article by Elke H. Zobel: "ISDN Teaches Btx to Sprint"]

[Text] On 1 August a pilot project started in the eastern Bundeslaender which is to show how videotext will function with the lines over there. Eastern Germany lags 10 years behind the west in this respect. But videotext is held to be a "new" service even in the west, and for many users it will only get really interesting through faster data transmission with ISDN [Integrated Services Digital Network].

The Theater on Academic Square in the eastern part of Berlin has apparently learned its market economy lessons well: By way of videotext it is possible not only to get information about the program, prices and the building, but—above all—to order tickets. Even the Interhotels in the new Bundeslaender, with a total of 17,000 beds and 18,000 restaurant chairs—are in the process (at press time it wasn't quite ready yet) of offering their services through videotext. With descriptions, prices, information and a page for room reservations, of course.

Whether videotext, which has just gotten under way in the "old FRG," will take hold faster in the new part remains to be seen and is primarily a question of the line quality over there. And it is bad. So bad, to begin with, that videotext operation with the modems offered by the Post Office (D-BT 03) common in the west is not possible. Expensive modems are therefore needed to smooth out the shortcomings with corresponding error correction protocols.

Situation Assessment To be Concluded in 1990

Within a few years the Post Office will then improve the infrastructure in the ex-GDR to such an extent that it will be possible for videotext to function smoothly. Precise statistical data on the conditions and usability of the network are to be ready by the end of the year, so that the Post Office can recommend which modems and terminal equipment can best be used for videotext over there.

In western Germany videotext was presented on the occasion of the International Telecommunications Fair in Berlin in 1977 and introduced after three years of testing in 1979. In 1980 pilot projects began with about 4,000 households in Duesseldorf/Neuss and the western part of Berlin. Since 1 September 1983 it has been possible to communicate through videotext in every community within the old Bundeslaender at the local rate.

Prognoses at that time from well-known market research institutes that within a short time videotext would reach more than a million subscribers turned out to be overly optimistic, however. On 1 February 1988 not quite 100,000 operating stations and private participants were connected to this service; however, their number has grown to about 240,000 connections in the last two years, an increase of nearly 2 ½ times.

Volume of Btx in the FRG; General Outline

Status	23 Sep 90	31 Aug 90
Connections	242,817	239,496
Suppliers	3,139	3,150
Guide pages	6,483	6,457
External computers	393	393
Suppliers with ER	1,699	1,687
Suppliers with GBG	907	910
Entries in GBG	286,074	2883,624
Videotext pages	702,145	695,762
Calls since the first of the month	4,011,136	5,605,496

In the Beginning There Were Miscalculations

"Videotext service is a telecommunications service of the German Bundespost Telekom, which offers access to information and data communication at favorable prices to a broad range of users. Through far-reaching standardization, simple operation and high visual quality it is possible to achieve a varied application spectrum." This is how videotext describes itself (in the words of Bundespost Telekom). The service, originally conceived for the private sector, so far has mainly caught on with commercial users; the private user still finds that flipping through mail order catalogs and looking for special offers is faster and more convenient manually than with the television screen. A money transfer order is—at least for all those who don't have an ISDN connection—quicker with the ballpoint pen than with videotext.

But with the networking of computers permitted in 1980 by the German Bundespost, videotext became interesting for business use, since not only Post Office-owned videotext centers but private, external, commercial computers can be connected. Thus, any type of data processing capacity and a nearly unlimited application spectrum has been made available.

The speed of the Post Office modem in analog operation (1200/75 bits per second) severely tests the user's patience, of course, primarily in the business area. Anyone used to working with personal computers can only suffer through the nerve-racking slowness of the videotext screen layout while gritting his teeth. But times are improving: Today there are already 40 locations where all videotext transmission exchanges have 1200/1200 bits per second access. Access with 2400/2400 bits per second is already available in 16 and soon in 37 places. Access with 64 kbits per second—only for ISDN participants—is being expanded from two to eight places.

Transitions to other services such as telex, Cityruf, fax and the gateway to the French Teletel are being added.

It will soon be possible, by calling the standard number 01910 at the local charge, to access videotext at speeds of 300/300, 1200/75, 1200/1200 and 2400/2400 bits per second and 64 kbits per second for ISDN connections. Long-distance dialing for the faster speeds, which was necessary until now, will then be eliminated. Anyone who has a touch-tone modem can establish a connection to the videotext system from the analog network in a few seconds. The new videotext access network is to become reality in 1992.

Acceptance Grows With Additional Expansion

The 3,000 so-called contractors and 2,000 subcontractors in the videotext system offer their products in three different ways: as national suppliers, as regional suppliers or as subcontractors.

National suppliers offer their videotext information in all Post Office computers, that is to say nationally. Bundespost Telekom charges 350 marks a month for supplying the master page.

This master page is the first page of a videotext program. It can be a page of greeting or a page of outline. The videotext participant gets to the master page by entering *Number# or *Name#. Further, additional videotext pages are needed which you can open as a supplier with the help of a dialog editor (can be reached through *911#).

For each videotext page opened, Telekom charges 2.25 marks a month in page storage fee. Additional charges are due if, for example, you tie in with a key word or use statistics for demand paging. (Information about fees can be had from Telekom or through *20000401142# in videotext.)

Dialog pages have the same storage fees as information pages. But for every order exceeding one dialog page, Telekom demands another 30 pfennig. As a supplier, it is possible to have dialog pages subject to charges charged to the customer.

The Bundespost is only making its regional computers available to regional suppliers. The choice is one or

several regional areas. For the first regional area you pay 50 marks a month, each additional one costs 15 marks. Page storage fees are also cheaper for regional suppliers than for national ones (45 pfennig per page for each regional area). Regional videotext sales pages can also be called up supraregionally, but then they cost the videotext participant 2 pfennig per calledup page.

Subcontractors make videotext information pages "available" to a supplier. For this the supplier requests from the Post Office a subcontractor guide page that costs 15 marks a month. The storage fees for the videotext information pages depend on the principal supplier. Subcontractors have the advantage that they can hook up to a videotext program with a high callup frequency.

ISDN "Puts Wings on" Videotext

The ISDN pilot program has been running in Mannheim and Stuttgart since November 1987. Two videotext transmission exchanges, Nuremberg and Duesseldorf, are today working with ISDN. This will finally enable videotext to outgrow its stumbling infancy and develop into the high-performance athlete of information technology.

ISDN is a digital network through which all Bundespost services (telephone, telex, fax, videotext) can be performed. It works with a data transmission rate of 64,000 bits per second. ISDN access to videotext will not influence its functions, but, on the contrary, will tackle its present lethargy: Images can be composed up to 50 times faster and videotext connections can be produced up to 10 times faster.

Participants with an ISDN-capable terminal and an ISDN connection have also been able to use videotext via ISDN. At the moment there are only the two entry points of Nuremberg and Duesseldorf, of course. Additional ones are to be added over the next few years, but until then ISDN videotext users must pay long-distance rates for connection to the entry points. Despite the faster transmission rate, this still costs more than the slow, analog variant.

Furthermore, from the videotext transmission exchange you reach external computers via the Datex-P network. Since this network is not yet connected to the ISDN network, the Datex-P speed of 9600 bits per second continues to determine the speed. But even this speed between external computer and videotext transmission exchange, as well as 64,000 bits per second between the videotext transmission exchange and the videotext participant terminal, is a clear improvement for the user.

User Is not Spared Cost/Benefit Calculations

As many ways as there are of using videotext, that is how many different types and configurations of equipment are available. Some are presented in the following.

Some questions need to be answered when choosing the right individual solution:

How often is the equipment expected to be used?

How much space may it take up?

What components can be connected with it?

The MultiTel videotext telephone, an added-feature telephone and videotext equipment in one, can be placed on any desk. It may be had with a black-and-white or color screen; it also has a keyboard with functional keys and additional documentation can be obtained via a connecting printer.

The MultiKom is a multifunctional communications terminal from the Post Office with an integrated modem and a black/white screen. It has no telephone component of its own, as does MultiTel, but can be connected to the telephone and selected via the call number index by pressing keys. A standard printer interface is part of it as well.

For videotext with a personal computer you need a software decoder or a videotext card. The existing keyboard and printer are fully supported. Depending on the user software, the data can be further processed in various ways; account processing, setting up address files, automatic dialog, reading in of text files and similar is conceivable.

Additional software can automate many videotext processes. For example, by pressing a single key it is possible to establish a videotext connection all the way to the intended page. Data can automatically be read out and further processed in user programs. Even electronic mailboxes can be downloaded automatically, and automatic sending of messages to lists of recipients is standard.

Videotext through television sets or home computers is only mentioned here for the sake of completeness, however, and as a rule is not under consideration in the business area.

Italy: Aerospace Consortium Presents Satellite System

91MI0172 Rome SPAZIO INFOAMZIONI in Italian 16 Jan 91 pp 3-4

[Text] Italspazio, the industrial consortium established by Aeritalia/Alenia and Laben in Rome, recently presented the results of a study on the LEOCOM [Low Earth Orbit Communications] system involving the use of small satellites for real-time and deferred telecommunications to the ESA (European Space Agency). The system is based on a "constellation" of LEOSTAR satellites to be used for alphanumerical data transmission, "facsimile" transmission, electronic mail, as well as to forward information on position. In particular, the LEOSTAR satellites (from a minimum of two or three to a maximum of 30-40 satellites) would be launched in circular polar orbits at a quota of approximately 780 km. According to Italspazio, this low-cost communications service could be used by road transport companies for

their mobile units and by navigation companies for their ships, by embassies, international humanitarian organizations (such as the United Nations, the Red Cross, or even the Vatican), and by the armed forces or various commercial firms.

Remaining in the sector of small applications satellites, Italspazio has designed MINISTAR, a low-cost small geostationary telecommunications satellite that aroused the interest of the ESA. Studies are also currently underway on the LEOSTAR platform, to be used both for communications and for environmental monitoring and Earth observation, and the HEOSTAR for telecommunications, navigation, and mobile communications using a "carriage" derived from the MINISTAR that operates in extremely elliptical or multistationary orbits.

TELECOMMUNICATIONS R&D

Fiber-Optic Link Project Approved

91AN0226 Chichester INTERNATIONAL TELECOMMUNICATIONS INTELLIGENCE in English 14 Jan 91 p 1

[Article: "Trans-Europa-Line Project Agreed"]

[Text] On 18 and 19 December, the Deutsche Bundespost Telekom (DBT) invited representatives from public telecommunications operators in Hungary, Poland, and Czechoslovakia to a conference in Bonn to discuss the possibilities of constructing a fibre-optic cable running across central Europe.

The parties have subsequently decided to initiate the Trans-Europa-Line (TEL) project. The cable will run from Frankfurt in West Germany through the south of the old East Germany to Warsaw, passing through Goerlitz on the (East) German/Polish border. At Goerlitz a spur will carry the cable through Prague and Bratislava to Budapest.

DBT said that TEL will noticeably improve the telecommunications infrastructure between East and West Europe and will, eventually, have beneficial effects for the economic development of many European countries.

TEL should be capable of providing tens of thousands of simultaneous telephone conversations and will ultimately connect Frankfurt to Moscow. Negotiations concerning this extension have already begun.

The total length, including the extension to Moscow, will be approximately 3,200 km, while required investment is estimated at 200 million German marks. Construction of the cable is expected to be carried out by the end of 1993. The transmission speed of the cable and the origin of suppliers is not yet indicated.

COCOM [Coordinating Committee for Export Control] restrictions on fibre-optic cables were relaxed in June 1990, with particular relaxations applying to Poland, Hungary, Czechoslovakia, and East Germany. For transmission equipment, export licence necessity remains to all (COCOM) listed countries with the exception of Poland, Hungary, and Czechoslovakia for certain equipment. Licences may be granted for all forms of digital transmission, including optical fibre systems, up to 156 Mbit/s.

For laser-based optical fibre systems, the wavelength is restricted to 1,370 nanometers.

From 1 July, East Germany has had almost all restrictions lifted or replaced by a much easier process of approval and, now, of course, is united with West Germany.

Previous restrictions still apply to the Soviet Union and any extension to the cable may have to operate at a much lower transmission speed. This is the subject of much argument as the Trans-Soviet Line Development Company has plans to install a fibre-optic system across the Soviet Union into western Europe and across to Japan but argues that the project is only viable at transmission speeds of 565 Mbit/s or greater.

More recently, Alcatel was awarded a contract to install a 250-km fibre-optic cable in Siberia. This cable would operate at 34 Mbit/s, but Alcatel said that the cable would comprise monomode fibres with an operating wavelength of 1,550 nanometres.

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15 April 1991